About This Guide

This chapter discusses the objectives, audience, organization, and conventions of the *Dial Solutions Quick Configuration Guide*.

Cisco documentation and additional literature are available on the Documentation CD-ROM. The CD is updated and shipped monthly so it might be more current than printed documentation. To order the Documentation CD, contact your local sales representative or call Customer Service. The CD is available both as a single CD and as an annual subscription. To order the CD, contact your local sales representative or call Cisco Customer Service. You can also access Cisco technical documentation via Cisco Connection Online on the World Wide Web URL http://www.cisco.com.

Document Objectives

This quick configuration guide describes the tasks you perform to solve common business problems with dial networking technologies. It presents the most common dial access tasks in a format that enables you to configure your access server quickly for the most common tasks. It does not describe every feature, but describes those tasks that you most likely need to do to configure your access server.

This guide begins with a case study followed by configuration scenarios. It also references detailed configuration options described in the Cisco IOS configuration guides and command references so that you can refer to these other documents for additional information.

Prerequisites

This guide assumes you understand the task for which your access server was purchased.

The configuration options indicated in this quick configuration guide are the recommended methods for performing the specified tasks. Although they are typically the easiest or the most straightforward method, they are not the only methods of configuring these tasks. If you know of another configuration method not presented in this guide, you can use it.

Audience

This guide is intended primarily for the following audiences:

- System administrators who are familiar with the fundamentals of router-based internetworking and who are responsible for installing and configuring internetworking equipment, but who might not be familiar with the specifics of Cisco products or the routing protocols supported by Cisco products.
- Customers who support dial-in users, but who have little experience with router-based networks.
- Customers who know one networking protocol (such as Novell IPX) and one LAN protocol (such as Ethernet), but have no additional networking background or experience.

Document Organization

This guide has two parts:

- Part 1, “Dial Case Study”—This part describes how to build a network that provides a dial-up environment using one Cisco AS5300. The access server supports remote users and remote LANs connecting with modems and ISDN routers. Only IP networking and basic security are described.This case study gives you a basic foundation from which you can scale to support larger dial implementations.
  - Chapter 1, “Dial Case Study Overview”
  - Chapter 2, “Cisco AS5300 Configuration”
  - Chapter 3, “Cisco 1604 Configuration”
  - Chapter 4, “Cisco 766 Configuration”
- Part 2, “Expanded Dial-Up Configurations”—This part provides comprehensive sample configurations for mixed protocol scenarios (IP, IPX, and AppleTalk). It also describes how to route over modem lines and set up security. Refer to the *Dial Solutions Configuration Guide* for more information.
  - Chapter 5, “IP, IPX, and AppleTalk Dial-Up Environments”
  - Chapter 6, “Routing across Modem Lines”
  - Chapter 7, “Security Configuration”

Document Conventions

This document uses the following conventions:

Convention	Description
^ or Ctrl	Represents the Control key. For example, when you read ^*D* or *Ctrl-D*, you should hold down the Control key while you press the D key. Keys are indicated in capital letters but are not case sensitive.
string	A string is defined as a nonquoted set of characters. For example, when setting an SNMP community string to public, do not use quotation marks around the string; otherwise, the string will include the quotation marks.

Examples use the following conventions:

Convention	Description
`screen`	Shows an example of information displayed on the screen.
`boldface screen`	Shows an example of information that you must enter.
< >	Nonprinting characters, such as passwords, appear in angled brackets.
!	Exclamation points at the beginning of a line indicate a comment line. They are also displayed by the Cisco IOS software for certain processes.
[ ]	Default responses to system prompts appear in square brackets.

The following conventions are used to attract the reader's attention:

Caution Means *reader be careful*. In this situation, you might do something that could result in equipment damage or loss of data.

Note Means *reader take note*. Notes contain helpful suggestions or references to materials not contained in this manual.

Timesaver Means the *described action saves time*. You can save time by performing the action described in the paragraph.

Command Syntax Conventions

Command descriptions use the following conventions:

Convention	Description
boldface	Indicates commands and keywords that are entered literally as shown.
italics	Indicates arguments for which you supply values; in contexts that do not allow italics, arguments are enclosed in angle brackets (< >).
[**x**]	Keywords or arguments that appear within square brackets are optional.
{**x** | **y** | **z**}	A choice of required keywords (represented by **x**, **y**, and **z**) appears in braces separated by vertical bars. You must select one.
[**x** {**y** | **z**}]	Braces and vertical bars within square brackets indicate a required choice within an optional element. You do not need to select one. If you do, you have some required choices.

Where to Go for More Information

Refer to the following list of resources:

- Cisco Connection Online
- Technical Assistance Center
- European Technical Assistance Center
- Documentation Set

Cisco Connection Online

Cisco Connection Online (CCO) is Cisco Systems' primary, real-time support channel. Maintenance customers and partners can self-register on CCO to obtain additional information and services.

Available 24 hours a day, 7 days a week, CCO provides a wealth of standard and value-added services to Cisco's customers and business partners. CCO services include product information, product documentation, software updates, release notes, technical tips, the Bug Navigator, configuration notes, brochures, descriptions of service offerings, and download access to public and authorized files.

CCO serves a wide variety of users through two interfaces that are updated and enhanced simultaneously: a character-based version and a multimedia version that resides on the World Wide Web (WWW). The character-based CCO supports Zmodem, Kermit, Xmodem, FTP, and Internet e-mail, and it is excellent for quick access to information over lower bandwidths. The WWW version of CCO provides richly formatted documents with photographs, figures, graphics, and video, as well as hyperlinks to related information.

You can access CCO in the following ways:

- WWW: http://www.cisco.com
- WWW: http://www-europe.cisco.com
- WWW: http://www-china.cisco.com
- Telnet: cco.cisco.com

- Modem: From North America, 408 526-8070; from Europe, 33 1 64 46 40 82. Use the following terminal settings: VT100 emulation; databits: 8; parity: none; stop bits: 1; and connection rates up to 28.8 kbps.

For a copy of CCO's Frequently Asked Questions (FAQ), contact cco-help@cisco.com. For additional information, contact cco-team@cisco.com.

Technical Assistance Center

If you are a network administrator and need personal technical assistance with a Cisco product that is under warranty or covered by a maintenance contract, contact Cisco's Technical Assistance Center (TAC) at 800 553-2447 or 408 526-7209, or tac@cisco.com. Emergency technical assistance (for network-down or severe network problems) is available 24 hours a day, 7 days a week.

For popular configuration tips and hints gathered from Cisco's Technical Assistance Center (TAC), go to the Hot Tips home page at the following URL. This URL is subject to change without notice.

http://www.cisco.com/warp/public/701/

If you choose to telephone the TAC for help, have the following information ready:

- Chassis serial number
- Maintenance contract number
- Software version level and hardware configuration (enter the **show version** command to display this information)
- Running software configuration. To display this information for Release 11.0 or later, enter the **show running config** command. For Release 11.0 or earlier, enter the **write terminal** command.

European Technical Assistance Center

Cisco and its European Service Partners coordinate all customer service in Europe, including hardware and software telephone technical support, onsite service, and module exchange and repair. For more information, contact the European TAC.

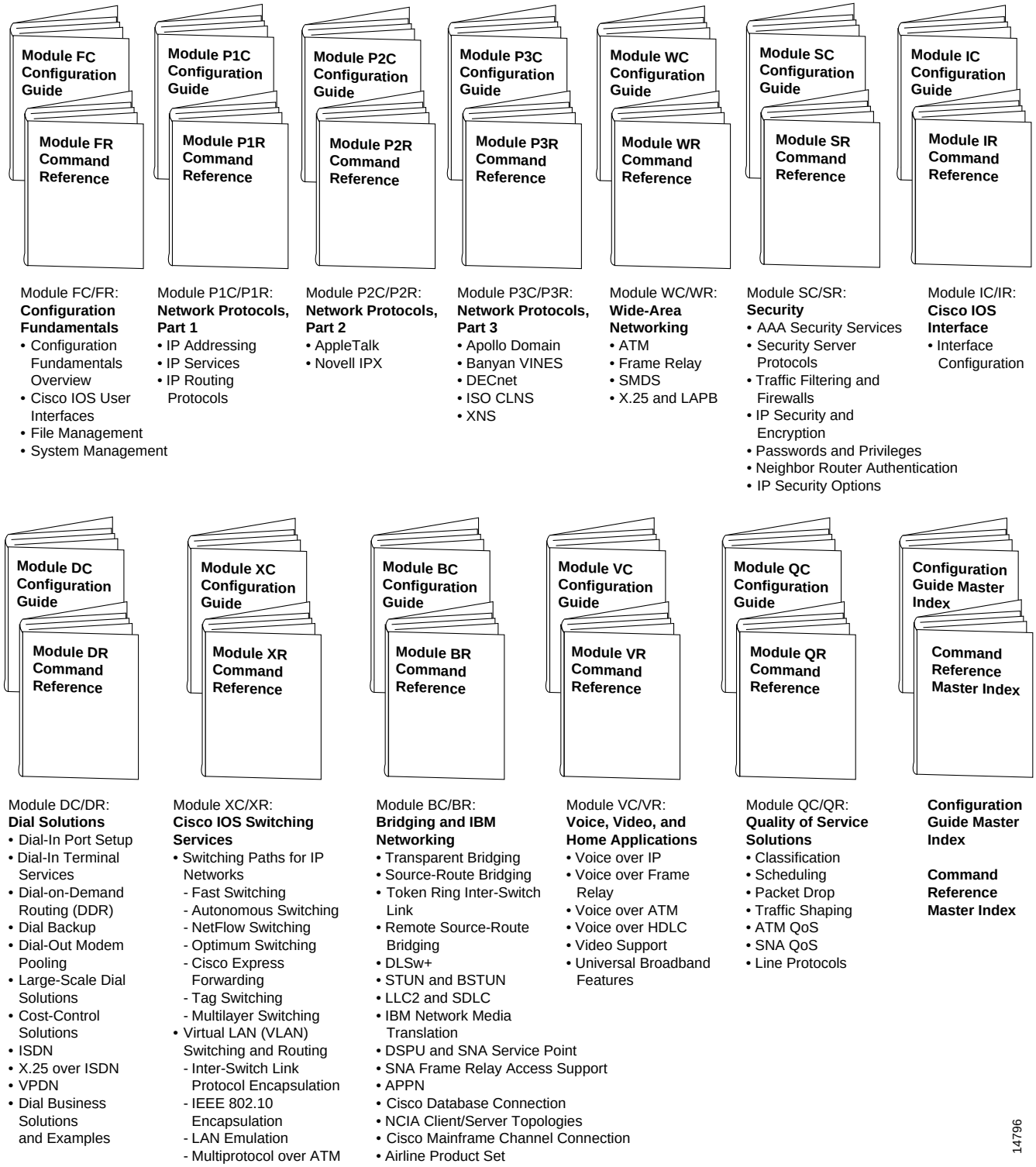
European TAC numbers and e-mail address are as follows:

- Phone: 32 2 778 42 42
- Fax: 32 2 778 43 00
- E-mail: euro-tac@cisco.com

Documentation Set

The Cisco IOS software documentation set is shown in the following figure:

Figure 1 Cisco IOS Software Documentation Modules



Module FC/FR:
Configuration Fundamentals
- Configuration Fundamentals Overview
- Cisco IOS User Interfaces
- File Management
- System Management

Module P1C/P1R:
Network Protocols, Part 1
- IP Addressing
- IP Services
- IP Routing Protocols

Module P2C/P2R:
Network Protocols, Part 2
- AppleTalk
- Novell IPX

Module P3C/P3R:
Network Protocols, Part 3
- Apollo Domain
- Banyan VINES
- DECnet
- ISO CLNS
- XNS

Module WC/WR:
Wide-Area Networking
- ATM
- Frame Relay
- SMDS
- X.25 and LAPB

Module SC/SR:
Security
- AAA Security Services
- Security Server Protocols
- Traffic Filtering and Firewalls
- IP Security and Encryption
- Passwords and Privileges
- Neighbor Router Authentication
- IP Security Options

Module IC/IR:
Cisco IOS Interface
- Interface Configuration

Module DC/DR:
Dial Solutions
- Dial-In Port Setup
- Dial-In Terminal Services
- Dial-on-Demand Routing (DDR)
- Dial Backup
- Dial-Out Modem Pooling
- Large-Scale Dial Solutions
- Cost-Control Solutions
- ISDN
- X.25 over ISDN
- VPDN
- Dial Business Solutions and Examples

Module XC/XR:
Cisco IOS Switching Services
- Switching Paths for IP Networks
  - Fast Switching
  - Autonomous Switching
  - NetFlow Switching
  - Optimum Switching
  - Cisco Express Forwarding
  - Tag Switching
  - Multilayer Switching
- Virtual LAN (VLAN) Switching and Routing
  - Inter-Switch Link Protocol Encapsulation
  - IEEE 802.10 Encapsulation
  - LAN Emulation
  - Multiprotocol over ATM

Module BC/BR:
Bridging and IBM Networking
- Transparent Bridging
- Source-Route Bridging
- Token Ring Inter-Switch Link
- Remote Source-Route Bridging
- DLSw+
- STUN and BSTUN
- LLC2 and SDLC
- IBM Network Media Translation
- DSPU and SNA Service Point
- SNA Frame Relay Access Support
- APPN
- Cisco Database Connection
- NCIA Client/Server Topologies
- Cisco Mainframe Channel Connection
- Airline Product Set

Module VC/VR:
Voice, Video, and Home Applications
- Voice over IP
- Voice over Frame Relay
- Voice over ATM
- Voice over HDLC
- Video Support
- Universal Broadband Features

Module QC/QR:
Quality of Service Solutions
- Classification
- Scheduling
- Packet Drop
- Traffic Shaping
- ATM QoS
- SNA QoS
- Line Protocols

Configuration Guide Master Index

Command Reference Master Index

Using Cisco IOS Software

This chapter provides helpful tips for understanding and configuring Cisco IOS software using the command-line interface (CLI).

- Getting Help
- Understanding Command Modes
- Using the No and Default Forms of Commands
- Saving Configuration Changes

For an overview of Cisco IOS software configuration, refer to the *Configuration Fundamentals Configuration Guide*.

For information on the conventions used in the Cisco IOS documentation set, refer to the "About this Guide" chapter at the beginning of this book.

Getting Help

Entering a question mark (**?**) at the system prompt displays a list of commands available for each command mode. You can also get a list of any command's associated keywords and arguments with the context-sensitive help feature.

To get help specific to a command mode, a command, a keyword, or an argument, use one of the following commands:

Command	Purpose
help	Obtain a brief description of the help system in any command mode.
*abbreviated-command-entry***?**	Obtain a list of commands that begin with a particular character string. (No space between command and question mark.)
abbreviated-command-entry<**Tab**>	Complete a partial command name.
?	List all commands available for a particular command mode.
command **?**	List a command's associated keywords. (Space between command and question mark.)
command keyword **?**	List a keyword's associated arguments. (Space between the keyword and question mark.)

Finding Command Options

This section provides an example of how to find and display the syntax for a command. The syntax can consist of optional or required keywords. To display keywords for a command, enter a question mark (**?**) at the configuration prompt, or after entering part of a command followed by a space. The Cisco IOS software displays a list of keywords available along with a brief description of the keywords. For example, if you were in global configuration mode, typed the command **arap**, and wanted to see all the keywords for that command, you would type **arap ?**.

The following table shows you how to find the command options for the following two commands:

- **controller t1 1**
- **cas-group 1 timeslots 1-24 type e&m-fgb dtmf**

Table 1 How to Find Command Options

Command	Comment

`Router> enable`
`Password: <password>`
`Router#`
	Enter the **enable** command and password to access privileged EXEC commands.
	You have entered privileged EXEC mode when the prompt changes to `Router#`.

`Router# config terminal`
`Enter configuration commands, one per line. End with CNTL/Z.`
`Router(config)#`
	Enter global configuration mode.
	You have entered global configuration mode when the prompt changes to `Router(config)#`.

`Router(config)# controller t1 ?`
`  <0-3>  Controller unit number`
`Router(config)# controller t1 1`
`Router(config-controller)#`
	Enter controller configuration mode by specifying the T1 controller that you want to configure using the **controller t1** global configuration command.
	Enter a **?** to display what you must enter next on the command line. In this example, you must enter a controller unit number from 0 to 3.
	You have entered controller configuration mode when the prompt changes to `Router(config-controller)#`.

`Router(config-controller)# ?`
`Controller configuration commands:`
`  cablelength  Specify the cable length for a DS1 link`
`  cas-group  Configure the specified timeslots for CAS (Channel Associate Signals)`
`  channel-group  Specify the timeslots to channel-group mapping for an interface`
`  clock  Specify the clock source for a DS1 link`
`  default  Set a command to its defaults`
`  description  Controller specific description`
`  ds0  ds0 commands`
`  exit  Exit from controller configuration mode`
`  fdl  Specify the FDL standard for a DS1 data link`
`  framing  Specify the type of Framing on a DS1 link`
`  help  Description of the interactive help system`
`  linecode  Specify the line encoding method for a DS1 link`
`  loopback  Put the entire T1 line into loopback`
`  no  Negate a command or set its defaults`
`  pri-group  Configure the specified timeslots for PRI`
`  shutdown  Shut down a DS1 link (send Blue Alarm)`
`Router(config-controller)#`
	Enter a **?** to display a list of all the controller configuration commands available for the T1 controller.

Table 1 How to Find Command Options (Continued)

Command	Comment

`Router(config-controller)# cas-group ?`
`  <0-23>  Channel number`
`Router(config-controller)# cas-group`
	Enter the command that you want to configure for the controller. In this example, the **cas-group** command is used.
	Enter a **?** to display what you must enter next on the command line. In this example, you must enter a channel number from 0 to 23.
	Because a <cr> is not displayed, it indicates that you must enter more keywords to complete the command.

`Router(config-controller)# cas-group 1 ?`
`  timeslots  List of timeslots in the cas-group`
`Router(config-controller)# cas-group 1`
	After you enter the channel number, enter a **?** to display what you must enter next on the command line. In this example, you must enter the **timeslots** keyword.
	Because a <cr> is not displayed, it indicates that you must enter more keywords to complete the command.

`Router(config-controller)# cas-group 1 timeslots ?`
`  <1-24>  List of timeslots which comprise the cas-group`
`Router(config-controller)# cas-group 1 timeslots`
	After you enter the **timeslots** keyword, enter a **?** to display what you must enter next on the command line. In this example, you must enter a list of timeslots from 1 to 24.
	You can specify timeslot ranges (for example, 1-24), individual timeslots separated by commas (for example 1, 3, 5), or a combination of the two (for example 1-3, 8, 17-24). The 16th time slot is not specified in the command line, because it is reserved for transmitting the channel signaling.
	Because a <cr> is not displayed, it indicates that you must enter more keywords to complete the command.

`Router(config-controller)# cas-group 1 timeslots 1-24 ?`
`  service  Specify the type of service`
`  type  Specify the type of signaling`
`Router(config-controller)# cas-group 1 timeslots 1-24`
	After you enter the timeslot ranges, enter a **?** to display what you must enter next on the command line. In this example, you must enter the **service** or **type** keyword.
	Because a <cr> is not displayed, it indicates that you must enter more keywords to complete the command.

`Router(config-controller)# cas-group 1 timeslots 1-24 type ?`
`  e&m-fgb  E & M Type II FGB`
`  e&m-fgd  E & M Type IIFGD`
`  e&m-immediate-start  E & M Immediate Start`
`  fxs-ground-start  FXS Ground Start`
`  fxs-loop-start  FXS Loop Start`
`  sas-ground-start  SAS Ground Start`
`  sas-loop-start  SAS Loop Start`
`Router(config-controller)# cas-group 1 timeslots 1-24 type`
	In this example, the **type** keyword is entered. After you enter the **type** keyword, enter a **?** to display what you must enter next on the command line. In this example, you must enter one of the signaling types.
	Because a <cr> is not displayed, it indicates that you must enter more keywords to complete the command.

Table 1 How to Find Command Options (Continued)

Command	Comment

`Router(config-controller)# cas-group 1 timeslots 1-24 type e&m-fgb ?`
`  dtmf  DTMF tone signaling`
`  mf  MF tone signaling`
`  service  Specify the type of service`
`  <cr>`
`Router(config-controller)# cas-group 1 timeslots 1-24 type e&m-fgb`
	In this example, the **e&m-fgb** keyword is entered. After you enter the **e&m-fgb** keyword, enter a **?** to display what you must enter next on the command line. In this example, you can enter the **dtmf**, **mf**, or **service** keyword to indicate the type of channel-associated signaling available for the **e&m-fgb** signaling type.
	Because a <cr> is displayed, it indicates that you can enter more keywords or press <cr> to complete the command.

`Router(config-controller)# cas-group 1 timeslots 1-24 type e&m-fgb dtmf ?`
`  dnis  DNIS addr info provisioned`
`  service  Specify the type of service`
`  <cr>`
`Router(config-controller)# cas-group 1 timeslots 1-24 type e&m-fgb dtmf`
	In this example, the **dtmf** keyword is entered. After you enter the **dtmf** keyword, enter a **?** to display what you must enter next on the command line. In this example, you can enter the **dnis** or **service** keyword to indicate the options available for **dtmf** tone signaling.
	Because a <cr> is displayed, it indicates that you can enter more keywords or press <cr> to complete the command.

`Router(config-controller)# cas-group 1 timeslots 1-24 type e&m-fgb dtmf` `Router(config-controller)#`	In this example, enter a <cr> to complete the command.

Understanding Command Modes

The Cisco IOS user interface is divided into many different modes. The commands available to you at any given time depend on which mode you are currently in. Entering a question mark (**?**) at the system prompt allows you to obtain a list of commands available for each command mode.

When you start a session on the router, you begin in user mode, often called EXEC mode. Only a limited subset of the commands are available in EXEC mode. In order to have access to all commands, you must enter privileged EXEC mode. Normally, you must enter a password to enter privileged EXEC mode. From privileged mode, you can enter any EXEC command or enter global configuration mode. Most of the EXEC commands are one-time commands, such as **show** commands, which show the current status of something, and **clear** commands, which clear counters or interfaces. The EXEC commands are not saved across reboots of the router.

The configuration modes allow you to make changes to the running configuration. If you later save the configuration, these commands are stored across router reboots. In order to get to the various configuration modes, you must start at global configuration mode. From global configuration mode, you can enter interface configuration mode, subinterface configuration mode, and a variety of protocol-specific modes.

ROM monitor mode is a separate mode used when the router cannot boot properly. If your router or access server does not find a valid system image when it is booting, or if its configuration file is corrupted at startup, the system might enter read-only memory (ROM) monitor mode.

Summary of Command Modes

The following table summarizes some of the main command modes of the Cisco IOS software.

Table 2 Summary of Main Command Modes

Command Mode	Access Method	Prompt	Exit Method
User EXEC	Log in.	`Router>`	Use the **logout** command.
Privileged EXEC	From user EXEC mode, use the **enable** EXEC command.	`Router#`	To exit back to user EXEC mode, use the **disable** command. To enter global configuration mode, use the **configure terminal** privileged EXEC command.
Global configuration	From privileged EXEC mode, use the **configure terminal** privileged EXEC command.	`Router(config)#`	To exit to privileged EXEC mode, use the **exit** or **end** command or press **Ctrl-Z**. To enter interface configuration mode, enter an **interface** configuration command.
Interface configuration	From global configuration mode, enter by specifying an interface with an **interface** command.	`Router(config-if)#`	To exit to global configuration mode, use the **exit** command. To exit to privileged EXEC mode, use the **exit** command or press **Ctrl-Z**. To enter subinterface configuration mode, specify a subinterface with the **interface** command.
Subinterface configuration	From interface configuration mode, specify a subinterface with an **interface** command.	`Router(config-subif)#`	To exit to global configuration mode, use the **exit** command. To enter privileged EXEC mode, use the **end** command or press **Ctrl-Z**.

Table 2 Summary of Main Command Modes (Continued)

Command Mode	Access Method	Prompt	Exit Method
ROM monitor	From privileged EXEC mode, use the **reload** EXEC command. Press the Break key during the first 60 seconds while the system is booting.	>	To exit to user EXEC mode, type **continue**.

For more information regarding command modes, refer to the "Using the Command Line Interface" chapter of the *Configuration Fundamentals Configuration Guide*.

Using the No and Default Forms of Commands

Almost every configuration command also has a **no** form. In general, use the **no** form to disable a function. Use the command without the keyword **no** to reenable a disabled function or to enable a function that is disabled by default. For example, IP routing is enabled by default. To disable IP routing, specify the **no ip routing** command and specify **ip routing** to reenable it. The Cisco IOS software command references provide the complete syntax for the configuration commands and describes what the **no** form of a command does.

Configuration commands can also have a **default** form. The **default** form of a command returns the command setting to its default. Most commands are disabled by default, so the **default** form is the same as the **no** form. However, some commands are enabled by default and have variables set to certain default values. In these cases, the **default** command enables the command and sets variables to their default values. The Cisco IOS software command references describe what the **default** form of a command does if the command is not the same as the **no** form.

Saving Configuration Changes

Enter the **copy system:running-config nvram:startup-config** command to save your configuration changes to your startup configuration so that they will not be lost if there is a system reload or power outage. For example:

```
Router# copy system:running-config nvram:startup-config
Building configuration...
```

It might take a minute or two to save the configuration. After the configuration has been saved, the following output appears:

```
[OK]
Router#
```

On most platforms, this step saves the configuration to nonvolatile random-access memory (NVRAM). On the Class A Flash file system platforms, this step saves the configuration to the location specified by the CONFIG_FILE environment variable. The CONFIG_FILE variable defaults to NVRAM.

Dial Case Study Overview

This case study builds a dial-up network environment using one Cisco AS5300. The access server supports remote users and remote LANs connecting with modems and ISDN routers. The remote routers in this case study are a Cisco 1604 and Cisco 766. Only IP and basic security are used.

This exercise gives you a basic foundation from which you can scale to support larger dial implementations.

The following sections are provided:

- "Scenario Description" on page 1
- "Design Architecture" on page 4
- "Overview of Tasks" on page 9
- "Related Documents and Web Tools" on page 10

Scenario Description

The case study is structured around the following three figures.

Figure 1-1 shows a headquarters network providing dial-up services to one small office/home office (SOHO), one remote office/branch office (ROBO), and remote modem users.

Figure 1-1 Business Scenario

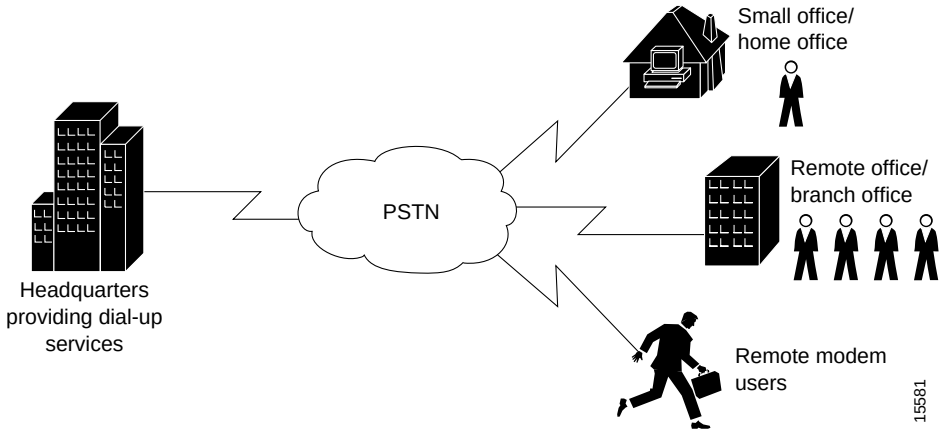
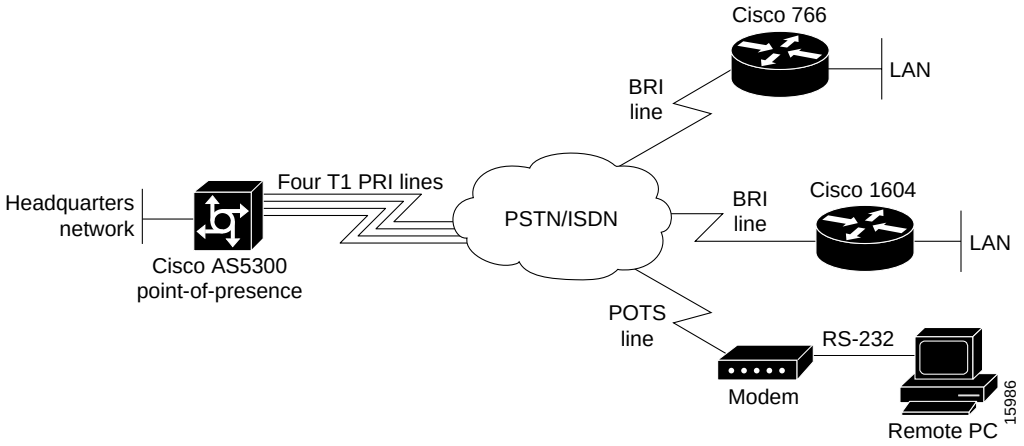


Figure 1-2 shows some of the physical elements present at layer 1 of the Open System Interconnection (OSI) reference model. The public switched telephone network (PSTN) provides the core interconnecting fabric between devices.

Figure 1-2 OSI Layer 1 Elements



In this scenario, a single Cisco AS5300 supports 96 concurrent modem and ISDN connections using four T1 PRI lines and 96 integrated modems. Modem connections are established via the Cisco IOS lines and corresponding asynchronous interfaces. Digital ISDN connections are established via the Cisco IOS channelized serial interfaces.

Figure 1-3 shows the layer 2 and layer 3 elements. The links going across the PSTN use the Point-to-Point Protocol (PPP). In this case study scenario PPP negotiates the link control protocol (LCP), CHAP or PAP authentication, and IP Control Protocol (IPCP) to bring up IP over PPP. IPCP is the network control protocol (NCP) used in this case study. IPCP is the mechanism that opens the links and negotiates the IP parameters.

Figure 1-3 OSI Layer 2 and Layer 3 Elements

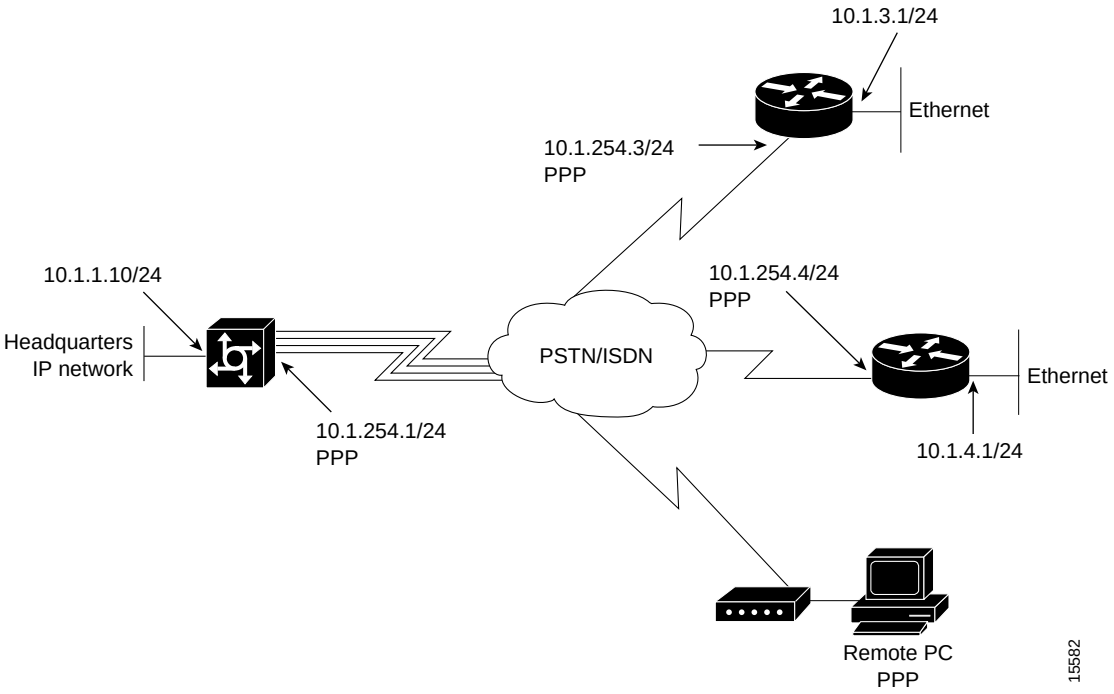


Table 1-1 summarizes the types of services provided by the headquarters POP to the remote nodes and sites. For more information, see Table 1-2 on page 4.

Table 1-1 Scenarios and Site Characteristics Provided by Headquarters

Scenario	Remote Hardware[1]	Services Required	Notes
Remote node modem	Modem	Asynchronous shell[2] (async shell) Asynchronous PPP (async PPP)	Dial in only[4]. Remote devices are assigned an IP address from a central pool.
Remote node ISDN	ISDN routers using port address translation (PAT)[3], PC-based ISDN terminal adapters	Synchronous PPP (sync PPP)	Dial in only[4]. PAT enabled. Connecting devices are assigned an IP address from a central pool.
Remote office LAN	Cisco 1604	Synchronous PPP	Dial in and dial out[4]. Distinct IP subnet. PAT not used.
Small office LAN	Cisco 766	Synchronous PPP	Dial in and dial out[4]. Distinct IP subnet. PAT not used.

1. This is the typical hardware required at the remote site.
2. Cisco IOS shell terminal services can be used for low-level troubleshooting on asynchronous connectivity. The shell is the service you use to access the command line interface. The shell provides you with a terminal screen.
3. PAT = Port address translation. Easy IP is an implementation of PAT. PAT vastly simplifies IP addressing design when supporting remote sites. This case study does not describe how to configure PAT. For more information, see the *Dial Solutions Configuration Guide*. PAT is mentioned in this table to show you how the technology is positioned in the remote access paradigm.
4. Unless otherwise stated, the terms “dial-in” and “dial-out” are from the perspective of the Cisco AS5300.

Design Architecture

The following sections provide the framework for this case study:

- Service Definitions
- Layer 3 IP Design
- IP Subnet Rationale
- Call Processing Components

Service Definitions

In this case study, the Cisco AS5300 offers three basic services: async shell, async PPP, and sync PPP. See Table 1-2.

These services are based on real needs as requested by the remote sites. To access these services, remote devices connect to the Cisco AS5300 via the PSTN.

Table 1-2 Services Provided by Headquarters

Service Term	Purpose	Physical Data Path[1]	Security Method Used
Async shell	Provides access to Cisco IOS terminal services (no PPP) to do the following:[2] • Change passwords • Access menus • Troubleshoot modem connections using a simple environment • Access other network resources via telnet	Client modems, POTS[3], Cisco IOS integrated modems, lines, and asynchronous interfaces	Login
Async PPP	• Provides IP (and multi-protocol) connectivity for remote node modem users • Supports any Internet application available using IP such as e-mail, web browsing, FTP, and Telnet.	Client modems, POTS[3], Cisco IOS integrated modems, lines, and asynchronous interfaces	PPP (CHAP, PAP, or login)
Sync PPP	• Provides IP (and multi-protocol) connectivity for BRI or PRI attached remote sites. • Supports any Internet application available using IP such as e-mail, web browsing, FTP, and Telnet[4].	End-to-end ISDN using B channels over a digital synchronous path, calls use interface serial channels (for example, S0:1, S0:2, and so forth)	PPP (CHAP or PAP)

1. This is the equipment and interface path used to deliver calls into the Cisco AS5300. See Figure 1-5.
2. Terminal services provided by the Cisco AS5300's integrated modems are terminated on TTY and VTY lines. The Cisco IOS shell is called the EXEC, which you can reach via a modem. The Cisco IOS shell is secured using "login" security. Authentication security associated with the EXEC is referred to as login. Sites offering terminal services can use menus to improve the user friendliness of the environment. For tips on how to create menus, see the *Configuration Fundamentals Configuration Guide*.
3. POTS = Plain old telephone service.
4. Terminal services via a shell are not available to synchronous link users (for example, ISDN routers and terminal adapters via a BRI channel). Only an asynchronous shell is available.

Layer 3 IP Design

This case study uses PPP to transport IP packets across the PSTN and into the end-user devices (remote LAN or remote node). IPCP is the specific service enabled over the PPP links. To deliver this service, the case study uses address space from 10.1.0.0 /16. See the following figures and tables for the IP subnetting plan.

Figure 1-4 IP Subnetting Diagram

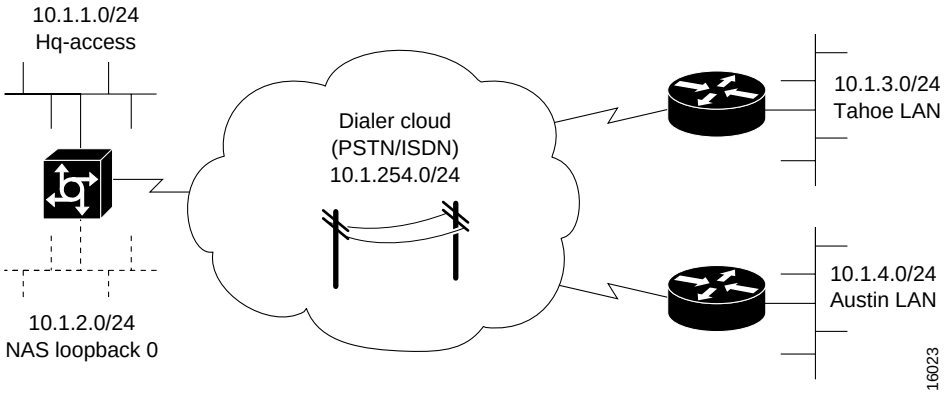


Table 1-3 IP Subnetting Plan

Subnet Name	Assigned Subnet	Location
Hq-access	10.1.1.0 /24	Hq-access Ethernet
NAS loopback 0[1]	10.1.2.0 /24	Loopback interface inside the Cisco AS5300
Dialer cloud	10.1.254.0 /24	Public switched telephone network
Tahoe LAN	10.1.3.0 /24	Tahoe Ethernet
Austin LAN	10.1.4.0 /24	Austin Ethernet
...[2]	...	...
...	...	...

1. NAS = network access server. The loopback subnet supports the remote node devices.
2. These dots mean that you can add additional subnets and remote LANs to this solution. This case study gives you a basic foundation from which you can scale to support larger dial implementations.

Using the subnetting plan and topologies shown in the previous tables and figures, a router naming and addressing plan is created in Table 1-4. Notice that the IP addresses are derived directly from the subnet plan.

Table 1-4 Router IP Addressing Plan

Router Name[1]	WAN IP Address	Ethernet IP Address
hq-sanjose	10.1.254.1 255.255.255.0	10.1.1.10 255.255.255.0
soho-tahoe	10.1.254.3 255.255.255.0	10.1.3.1 255.255.255.0
robo-austin	10.1.254.4 255.255.255.0	10.1.4.1 255.255.255.0
...[2]	...	...
...	...	...

1. Using the subnetting plan and topologies shown in the previous tables and figures, a router naming and addressing plan is created in are now assigned host names.
2. These dots mean that you can add additional subnets and remote LANs to this solution. This case study gives you a basic foundation from which you can scale to support larger dial implementations.

IP Subnet Rationale

This section describes each IP subnet and its design criteria. IP route summarization occurs at the gateway that connects the NAS to the IP backbone. IP range 10.1.0.0/16 is propagated to the backbone.

Hq-access Subnet

IP subnet 10.1.1.0/24 is assigned to the Ethernet connected to the Cisco AS5300. If additional access servers and POP management devices are needed, they are assigned to this IP subnet. Using one subnet for the entire headquarters dial access POP simplifies network design.

NAS Loopback 0 Subnet

IP subnet 10.1.2.0/24 is assigned to the loopback interface on the Cisco AS5300. This is the subnet used to host the remote node IP addresses. The access server has an IP pool range of 10.1.2.2 through 10.1.2.97.

Remote nodes dialing in request addresses from the Cisco AS5300's local IP address pool. This IP pool behaves like an address server handing out IP addresses to remote nodes during IPCP negotiation (a component of PPP).

Dialer Cloud Subnet

IP subnet 10.1.254.0/24 is assigned to the PSTN/ISDN. The static IP addresses are described in Table 1-4. See the column “WAN IP Address.” The PSTN/ISDN becomes a “dialer cloud” from the Cisco IOS perspective. Dialer interfaces are used to connect to this dialer cloud. BRI and PRI interfaces are also dialer interfaces and use the same dial-on-demand routing (DDR) mechanisms to open and close circuit-switched connections.

A key design decision in this case study is to number the dialer cloud subnet. (That is, IP unnumbered is not used on these interfaces.) Numbering the dialer cloud ports to match the remote LAN supported by the same remote device is part of our design strategy to simplify administration. For example, remote subnet 10.1.3.0/24 is connected to the same remote site as dialer cloud node 10.1.254.3. IP node 10.1.254.4 supports IP subnet 10.1.4.0/24.

On the Cisco AS5300, all the individual serial channel interfaces are grouped together under one master dialer interface. As the individual remote sites connect, their configurations must coordinate with the configuration of the master dialer interface.

Tahoe and Austin LAN Subnets

IP subnet 10.1.3.0/24 is assigned to the Ethernet connected to the Cisco 766 (soho-tahoe). IP subnet 10.1.4.0/24 is assigned to the Cisco 1604 (robo-austin) Ethernet. Each site that supports a distinct IP subnet must be assigned its own distinct IP subnet address space. Routers with LANs behind them must have their own distinct IP subnets when not using PAT.

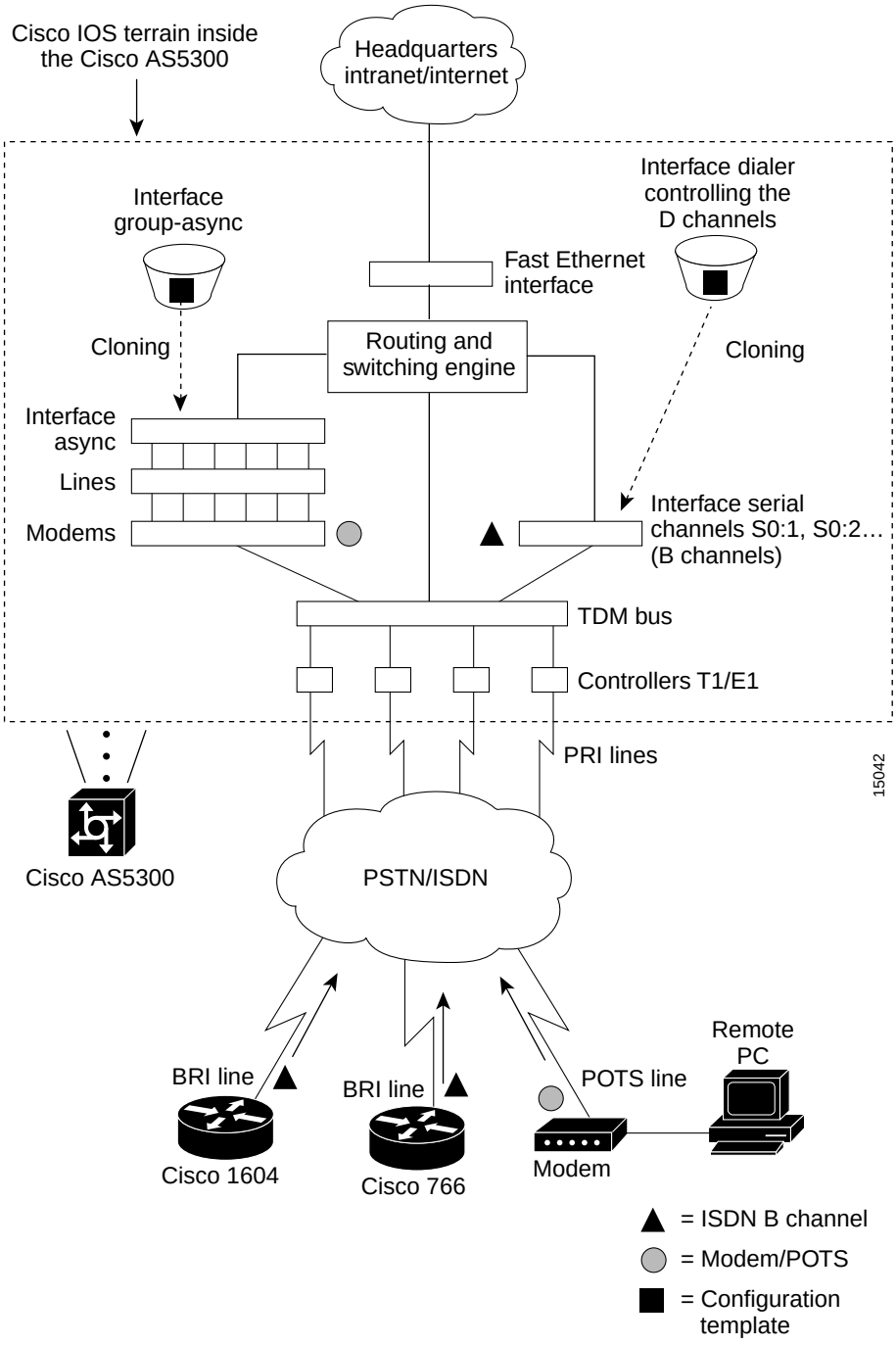
These remote LAN routers point to the central site as the default route. The hq-sanjose NAS is configured with static routes to the remote IP subnets.

Call Processing Components

Figure 1-5 illustrates the connectivity path as calls come into the Cisco AS5300. The contents inside the dotted square box are the internal components of the Cisco AS5300. Both analog modem and digital calls enter the Cisco AS5300 via the E1/T1 controllers. Incoming modem calls are connected with the integrated modems and routed to the asynchronous interfaces. Incoming sync PPP calls are connected to the individual serial channels (for example, S0:1 and S0:2).

As shown in Figure 1-5, one PPP/modem user consumes resources from one channel, one integrated modem, one line, and one asynchronous interface. An ISDN B-channel user connects directly via a channel of the T1 and a serial B-channel. The group-async and dialer interfaces are used to control the interfaces’ behavior and configuration of async and serial channels.

Figure 1-5 Call Processing Components



Overview of Tasks

The network devices in this case study are manually configured using Cisco IOS software. The automatic Cisco IOS setup script is not used. This setup script usually runs when no startup configuration is found in NVRAM (for example, when powering up a new router).

Here is the action plan to build the network. For step-by-step configuration tasks, refer to the device-specific configuration chapters that follow.

Step 1 Set up async shell services on the Cisco AS5300. See chapter 2 “Cisco AS5300 Configuration.”

- Configuring the Host Name, Password, and Time Stamps
- Configuring Local AAA Security
- Configuring the Fast Ethernet 100BaseT Interface
- Commissioning the T1 Controllers
- Configuring the Serial Channels to Let Modem Calls Come in
- Configuring the Modems and Lines
- Testing Async Shell Connections

Step 2 Set up async PPP services on the Cisco AS5300. See chapter 2 “Cisco AS5300 Configuration.”

- Setting Up IP Address Pools
- Configuring the Group-Async Interface
- Testing Async PPP Connections

Step 3 Set up synchronous PPP services on the Cisco AS5300. See chapter 2 “Cisco AS5300 Configuration.”

- Configuring DDR
- Configuring Definitions for Remote LAN Sites
- Configuring a Backhaul Routing Protocol
- Confirming the Final Running Configuration
- Saving the Configuration
- Testing Sync PPP Connections to Remote LANs
- Adding More Remote LAN Sites as Needed

Step 4 Configure the Cisco 1604 to dial into the Cisco AS5300. See chapter 3 “Cisco 1604 Configuration.”

- Configuring the Host Name, Password, and Time Stamps
- Configuring Local AAA Security
- Configuring the Ethernet Interface
- Configuring BRI
- Configuring DDR
- Testing Connections to the Cisco AS5300

- Confirming the Final Running Configuration
- Saving the Configuration

Step 5 Configure the Cisco 766 to dial into the Cisco AS5300. See chapter 4 “Cisco 766 Configuration.”

- Configuring System Level Settings
- Configuring the LAN Profile
- Configuring the Site Profile hq-sanjose
- Testing Connections to the Cisco AS5300
- Confirming the Final Running Configuration

Related Documents and Web Tools

Refer to the following online resources for more information:

- *Internetworking Case Studies*—Provides practical examples of how to implement Cisco IOS software features. Case studies address implementation concerns and show how to apply features to their best advantage. Detailed configuration file examples and network diagrams are included.

  http://www.cisco.com/univercd/cc/td/doc/cisintwk/ics/index.htm

- *Cisco Access Dial Configuration Cookbook*—Contains common configurations or recipes to configure various access routers and dial technologies. It covers common configurations for async, dial-on-demand routing (DDR), integrated services digital network (ISDN), and other access dial concepts including basic security. It also provides configurations for the Cisco 700, AS5200, and AS5300. You must be a registered Cisco Connection Online (CCO) user to gain access to this publication.

  http://www.cisco.com/warp/customer/793/access_dial/

- *Dial Solutions Configuration Guide and Command Reference*—Provides a comprehensive library of Cisco’s dial software features, which are configured using the command line interface.

  http://www.cisco.com/univercd/cc/td/doc/product/software/ios113ed/113ed_cr/index.htm

- *Internetworking Technology Overview, Point-to-Point Protocol*—Describes the background and general operation of PPP.

  http://www.cisco.com/univercd/cc/td/doc/cisintwk/ito_doc/55168.htm

- *Troubleshooting Engine*—Helps you solve common problems involving hardware, configuration, and performance.

  http://te.cisco.com/cgi-bin/webcgi.exe?New,KB=TE

- *Cisco AS5x00 Access Server Documentation*—Includes software and hardware configuration guides for Cisco's access server product line.

  http://www.cisco.com/univercd/cc/td/doc/product/access/acs_serv/index.htm

Note These URLs can change without notice.

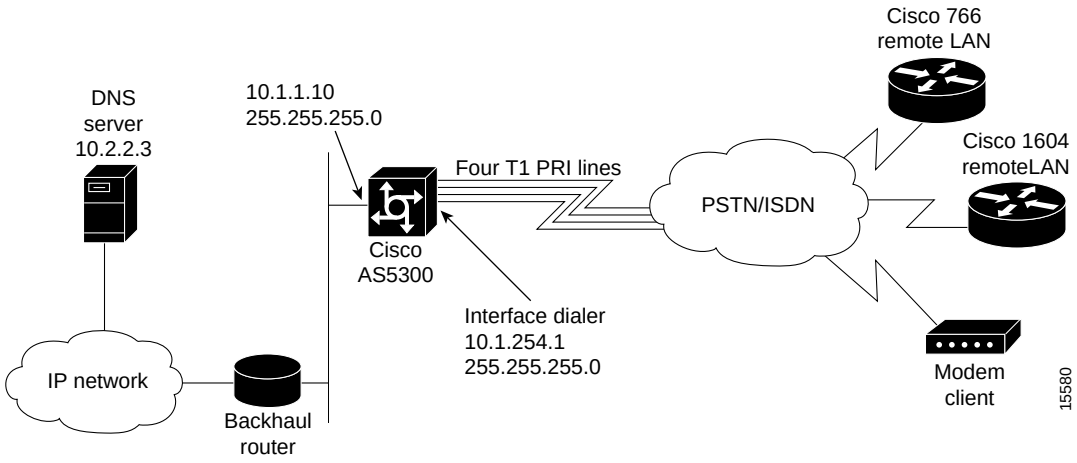
Cisco AS5300 Configuration

This chapter describes how to configure the Cisco AS5300 to receive calls from the Cisco 1604, Cisco 766, and remote modem users.

Site Profile Characteristics

Figure 2-1 shows the network topology from the Cisco AS5300's perspective.

Figure 2-1 Network Topology



Note Before you perform the configuration tasks in this chapter, be sure you understand the overall dial case action plan described in the previous chapter "Dial Case Study Overview."

Table 2-1 provides detailed information about each end of the connection. This is the network administrator's top-level design table.

Table 2-1 Site Characteristics

Site Hardware	WAN IP Address	Ethernet IP Address	Assigned Phone Number	Host Name/ Username[1]	Username Password[1]
Cisco AS5300[2]	10.1.254.1 255.255.255.0[3]	10.1.1.10 255.255.255.0	4085551234[4]	hq-sanjose	hq-sanjose-pw
Cisco 766	10.1.254.3 255.255.255.0	10.1.3.1 255.255.255.0	Directory number = 5305558084	soho-tahoe	tahoe-pw
Cisco 1604	10.1.254.4 255.255.255.0	10.1.4.1 255.255.255.0	Directory number = 5125554433	robo-austin	austin-pw

1. Make sure to use your own host names and passwords. For example *soho-tahoe* and *tahoe-pw* are for this case study's purpose only.
2. The subnet 10.1.2.0 255.255.255.0 is used for the loopback interface and the local IP address pools.
3. This address is configured on the Cisco AS5300's dialer interface.
4. This is the PRI telephone number assigned to the central site (hq-sanjose). This number is often called the hunt group number, which distributes calls among the available B channels. All four PRI trunks on the Cisco AS5300 should be assigned to this number by the PRI provider.

Cisco IOS Release 12.0 is running inside the access server. If the startup configuration is blank, the following screen is displayed at bootup. The automatic setup script is engaged. Enter **no** when you are asked the question, "Would you like to enter the initial configuration dialog? [yes]: **no**."

In this case study, the Cisco AS5300 is manually configured using the Cisco IOS software. The automatic setup script is not used.

Note To enhance readability throughout this chapter, the most important output fields are highlighted with **bold** font. The commands you enter are also **bold** but are preceded by a router prompt.

```
Copyright (c) 1994-1995 by cisco Systems, Inc.
AS5300 processor with 32768 Kbytes of main memory
program load complete, entry point: 0x80008000, size: 0xf4b10

Self decompressing the image : ########################################################
################################################################################
################################################################################
################################################################################
################################################################################
################## [OK]

          Restricted Rights Legend

Use, duplication, or disclosure by the Government is
subject to restrictions as set forth in subparagraph
(c) of the Commercial Computer Software - Restricted
Rights clause at FAR sec. 52.227-19 and subparagraph
(c) (1) (ii) of the Rights in Technical Data and Computer
Software clause at DFARS sec. 252.227-7013.

           cisco Systems, Inc.
           170 West Tasman Drive
           San Jose, California 95134-1706
```

```
Cisco Internetwork Operating System Software
IOS (tm) 5300 Software (C5300-JS-M), Version 12.0(x)
Copyright (c) 1986-1998 by cisco Systems, Inc.
Compiled Tue 07-Jul-98 15:26 by xxxx
Image text-base: 0x600088E8, data-base: 0x608F4000
cisco AS5300 (R4K) processor (revision A.04) with 32768K/8192K bytes of memory.
Processor board ID 04614948
R4700 processor, Implementation 33, Revision 1.0 (512KB Level 2 Cache)
Bridging software.
X.25 software, Version 3.0.0.
SuperLAT software copyright 1990 by Meridian Technology Corp).
TN3270 Emulation software.
Primary Rate ISDN software, Version 1.1.
Backplane revision 1
Manufacture Cookie is not programmed.
1 Ethernet/IEEE 802.3 interface(s)
1 FastEthernet/IEEE 802.3 interface(s)
96 terminal line(s)
4 Channelized T1/PRI port(s)
128K bytes of non-volatile configuration memory.
16384K bytes of processor board System flash (Read/Write)
4096K bytes of processor board Boot flash (Read/Write)
Cisco Internetwork Operating System Software
IOS (tm) 5300 Software (C5300-JS-M), Version 12.0(x),
Copyright (c) 1986-1998 by cisco Systems, Inc.
Compiled Tue 07-Jul-98 15:26 by xxx
00:00:50: %MICA-5-BOARDWARE_RUNNING: Slot 2 is running boardware version 2.5.0.8
--- System Configuration Dialog ---

At any point you may enter a question mark '?' for help.
Use ctrl-c to abort configuration dialog at any prompt.
Default settings are in square brackets '[]'.


Would you like to enter the initial configuration dialog? [yes]: no

Press RETURN to get started!

Router>
```

Note Use the **show version** command to determine if the access server is recognizing all of its modems cards. For example, the output field “96 terminal line(s)” tells you that the chassis can find all 96 integrated modems.

Overview of Tasks

Perform the following steps to configure the access server:

- Set up asynchronous shell services:
  - “Step 1—Configuring the Host Name, Password, and Time Stamps” on page 5
  - “Step 2—Configuring Local AAA Security” on page 6
  - “Step 3—Configuring the Fast Ethernet 100BaseT Interface” on page 8
  - “Step 4—Commissioning the T1 Controllers” on page 10
  - “Step 5—Configuring the Serial Channels to Let Modem Calls Come in” on page 14
  - “Step 6—Configuring the Modems and Lines” on page 18
  - “Step 7—Testing Async Shell Connections” on page 19
- Set up asynchronous PPP services:
  - “Step 8—Setting Up IP Address Pools” on page 27
  - “Step 9—Configuring the Group-Async Interface” on page 28
  - “Step 10—Testing Async PPP Connections” on page 31
- Set up synchronous PPP services:
  - “Step 11—Configuring DDR” on page 36
  - “Step 12—Configuring Definitions for Remote LAN Sites” on page 39
  - “Step 13—Configuring a Backhaul Routing Protocol” on page 41
  - “Step 14—Confirming the Final Running Configuration” on page 42
  - “Step 15—Saving the Configuration” on page 44
  - “Step 16—Testing Sync PPP Connections to Remote LANs” on page 44
  - “Step 17—Adding More Remote LAN Sites as Needed” on page 44

Step 1—Configuring the Host Name, Password, and Time Stamps

Assign a host name to the Cisco AS5300, enable basic security, and turn on time stamping. Configuring a host name allows you to distinguish between different network devices. Enable passwords allow you to prevent unauthorized configuration changes. Time stamps help you trace debug output for testing connections. Not knowing exactly when an event occurs hinders you from examining background processes.

Configure

To configure the host name, enable password, and time stamps use the following commands beginning in user EXEC mode:

Step	Command	Purpose
1	`Router> enable`	Enter privileged EXEC mode.
2	`Router# configure terminal` `Enter configuration commands, one per line. End with CNTL/Z.`	Enter global configuration mode[1].
3	`Router(config)# hostname hq-sanjose`	Assign a host name to the access server[2]. This host name is typically used during authentication with PPP peers.
4	`hq-sanjose(config)# enable secret letmein`	Enter a secret enable password, which secures privileged EXEC mode[3].
5	`hq-sanjose(config)# service password-encryption`	Encrypt passwords in the configuration file for greater security[4].
6	`hq-sanjose(config)# service timestamps debug datetime msec` `hq-sanjose(config)# service timestamps log datetime msec`	Enable millisecond time stamping on debug and logging output. Time stamps are useful for detailed access troubleshooting.

1. If the logging output generated by the access server interferes with your terminal screen, redisplay your current command line using the **Tab** key.
2. The step is verified by the router prompt changing from `Router(config)#` to `hq-sanjose(config)#`.
3. Make sure to change “letmein” to your own secret password.
4. Additional measures should be used, as the passwords are not strongly encrypted by today’s standards.

Verify

To verify the configuration:

- Try logging in with your new enable password. Exit out of enable mode using the **disable** command. The prompt changes from `hq-sanjose#` to `hq-sanjose>`. Enter the **enable** command followed by your password. The **show privilege** command shows the current security privilege level.

```
hq-sanjose# disable
hq-sanjose> enable
Password: letmein
hq-sanjose# show privilege
Current privilege level is 15
hq-sanjose#
```

- Enter the **show running** command:

```
hq-sanjose# show running
Building configuration...
Current configuration:
!
version 12.0
service timestamps debug datetime msec
service timestamps log datetime msec
service password-encryption
!
hostname hq-sanjose
!
enable secret 5 $1$.voA$9/8.Zoil3jeWJMP6hEE6U0
!
----- snip ----
```

Tips

If you have trouble:

- Make sure **Caps Lock** is off.
- Make sure you entered the correct passwords. Passwords are case sensitive.
- Password protection is very important. Cisco highly recommends that you use the **show tech-support** command to report system configuration information to Cisco TAC:

```
hq-sanjose# show tech-support ?
  ipmulticast  IP multicast related information
  page         Page through output
  password     Include passwords
  rsvp         IP RSVP related information
  <cr>
```

Step 2—Configuring Local AAA Security

The Cisco IOS security model to use on all Cisco devices is authentication, authorization, and accounting (AAA). AAA provides the primary framework through which you set up access control on the access server.

- Authentication—Who are you?
- Authorization—What can you do?
- Accounting—What did you do?

In this case study, the same authentication method is used on all interfaces. AAA is set up to use the local database configured on the router. This local database is created with the **username** configuration commands.

Note After you finish setting up basic security, you can enhance the security solution by extending it to an external TACACS+ or RADIUS server. This case study describes local AAA security only.

Configure

To configure local AAA security, use the following commands beginning in global configuration mode:

Step	Command	Purpose
1	`hq-sanjose(config)# username joe-admin password joe-password`	Create a local login database and username for yourself[1]. This step also prevents you from getting locked out of the access server.
2	`hq-sanjose(config)# aaa new-model`	Initiate the AAA access control system. This step immediately locks down login and PPP authentication.
3	`hq-sanjose(config)# aaa authentication login default local`	Configure AAA to perform login authentication using the local username database. The **login** keyword authenticates shell/EXEC users.
4	`hq-sanjose(config)# aaa authentication ppp default if-needed local`	Configure PPP authentication to use the local database if the session was not already authenticated by **login**.

1. Make sure to change “joe-admin” to your own username and “joe-password” to your own password.

Verify

To verify the configuration:

- Try to log in with your username:password. Enter the **login** command at the EXEC shell prompt. If you get in, the login authentication is working with your local username. Do not disconnect your access server session until you can log in successfully. (If you get locked out, you will need to perform password recovery by rebooting the access server.)

```
hq-sanjose# login

User Access Verification

Username: joe-admin
Password: joe-password

hq-sanjose#
```

- Enter the **show running** command:

```
hq-sanjose# show running
Building configuration...
Current configuration:
!
version 12.0
service timestamps debug datetime msec
service timestamps log datetime msec
service password-encryption
!
hostname hq-sanjose
```

```
!
aaa new-model
aaa authentication login default local
aaa authentication ppp default if-needed local
enable secret 5 $1$.voA$9/8.Zoil3jeWJMP6hEE6U0
!
username joe-admin password 7 <removed>
!
----- snip ----
```

Step 3—Configuring the Fast Ethernet 100BaseT Interface

Assign an IP address, line speed, and duplex mode to the Fast Ethernet interface. The Fast Ethernet interface supports 10- and 100-Mbps speeds.

The default priority search order for auto negotiating the line speed is as follows:

1. 100Base-TX full duplex
2. 100Base-TX half duplex
3. 10Base-T full duplex
4. 10Base-T half duplex

Configure

To configure the Fast ethernet 100BaseT interface, use the following commands beginning in global configuration mode:

Step	Command	Purpose
1	`hq-sanjose(config)# interface fastethernet 0` `hq-sanjose(config-if)# ip address 10.1.1.10 255.255.255.0`	Configure the IP address and subnet mask on the Fast Ethernet interface.
2	`hq-sanjose(config-if)# speed auto`	Auto negotiate the line speed based on the peer routers, hubs, and switch media.
3	`hq-sanjose(config-if)# duplex auto`	Auto negotiate duplex mode.
4	`hq-sanjose(config-if)# no shutdown` `%LINK-3-UPDOWN: Interface FastEthernet0, changed state to up`	Bring up the interface[1].

1. This command changes the state of the interface from administratively down to up.

Verify

To verify the configuration:

- Enter the **show ip interface brief** command to view the interface's status. The "`up`" display field should appear under the Status and Protocol columns. The display fields "`down`" or "`administratively down`" signify a connection problem.

```
hq-sanjose# show ip interface brief fastethernet 0
Interface              IP-Address      OK?       Method      Status        Protocol
FastEthernet0          10.1.1.10       YES       manual       up           up
```

- Try pinging a device in your network, such as a backhaul router or the backbone gateway:

```
hq-sanjose# ping 10.1.1.1

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.1.1, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 4/5/8 ms
```

- Enter the **show interface fastethernet 0** command to see detailed interface information. Look for the display field "`FastEthernet 0 is up, line protocol is up`." This means that the access server sees its own sent and received keepalives.

```
hq-sanjose# show interface fastethernet 0
FastEthernet0 is up, line protocol is up
  Hardware is DEC21140AE, address is 00e0.1e6b.2ffb (bia 00e0.1e6b.2ffb)
  Internet address is 10.1.1.10 /24
  MTU 1500 bytes, BW 100000 Kbit, DLY 100 usec, rely 255/255, load 1/255
  Encapsulation ARPA, loopback not set, keepalive set (10 sec), auto duplex,
  100BaseTX/FX, auto speed
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input 00:00:05, output 00:00:05, output hang never
  Last clearing of "show interface" counters never
  Queueing strategy: fifo
  Output queue 0/40, 0 drops; input queue 0/120, 0 drops
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     282 packets input, 68476 bytes, 0 no buffer
     Received 282 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     0 watchdog, 0 multicast
     0 input packets with dribble condition detected
     176 packets output, 16936 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 babbles, 0 late collision, 0 deferred
     0 lost carrier, 0 no carrier
     0 output buffer failures, 0 output buffers swapped out
```

- Enter the **show running** command:

```
hq-sanjose# show running
Building configuration...
Current configuration:
!
----- snip ----
!
interface FastEthernet0
 ip address 10.1.1.10 255.255.255.0
 no ip directed-broadcast
 no ip route-cache
 no ip mroute-cache
 duplex auto
 speed auto
!
----- snip ----
```

Tips

If you have trouble:

- Make sure the cable connections are not loose or disconnected.
- Make sure you are using the correct IP address.

Step 4—Commissioning the T1 Controllers

Configure the T1 controllers to allow calls to come into the access server. You must specify the following information for each controller: framing type, line code type, clock source, and timeslot assignments.

Configure

To configure the controllers, use the following commands beginning in global configuration mode:

Step	Command	Purpose
1	`hq-sanjose(config)# isdn switch-type primary-ni`	Enter your telco's switch type. This example uses primary national ISDN 1.
2	`hq-sanjose(config)# controller t1 0`	Enter controller configuration mode for the first T1 controller, which is 0. The controller ports are labeled 0 through 3 on the quad T1/PRI card.
3	`hq-sanjose(config-controller)# framing esf`	Enter the T1 framing type. This example uses extended super frame.
4	`hq-sanjose(config-controller)# linecode b8zs`	Enter the T1 line code type. This example uses B8ZS.
5	`hq-sanjose(config-controller)# clock source line primary`	Configure the access server to get its primary clocking from the T1 line assigned to controller 0. Line clocking comes from the remote switch.
6	`hq-sanjose(config-controller)# pri-group timeslots 1-24`	Assign all 24 T1 timeslots as ISDN PRI channels[1].
7	`hq-sanjose(config-controller)# exit`	Exit back to global configuration mode.

8	`hq-sanjose(config#) controller t1 1`
	`hq-sanjose(config-controller)# framing esf`
	`hq-sanjose(config-controller)# linecode b8zs`
	`hq-sanjose(config-controller)# clock source line secondary`
	`hq-sanjose(config-controller)# pri-group timeslots 1-24`
	`hq-sanjose(config-controller)# exit`
		Configure the second controller, controller T1 1.
		Set the clocking to **secondary**. If the line clocking from controller T1 0 fails, the access server will receive its clocking from controller T1 1.

9	`hq-sanjose(config#) controller t1 2`
	`hq-sanjose(config-controller)# framing esf`
	`hq-sanjose(config-controller)# linecode b8zs`
	`hq-sanjose(config-controller)# clock source internal`
	`hq-sanjose(config-controller)# pri-group timeslots 1-24`
	`hq-sanjose(config-controller)# exit`
	`hq-sanjose(config#) controller t1 3`
	`hq-sanjose(config-controller)# framing esf`
	`hq-sanjose(config-controller)# linecode b8zs`
	`hq-sanjose(config-controller)# clock source internal`
	`hq-sanjose(config-controller)# pri-group timeslots 1-24`
	`hq-sanjose(config-controller)# exit`
	`hq-sanjose(config#)`
		Configure the remaining two controllers.
		Set both clocking entries to **internal**. The primary and secondary clock sources have already been assigned.

1. After you enter this command, a D-channel serial interface is instantly created (for example S0:23, S1:23, and so on) in the configuration file as well as the individual B-channel serial interfaces (for example S0:0, S0:1, ...). The D-channel interface functions like a dialer for all the 23 B channels using the controller.

Verify

To verify the configuration:

- Use the **show controller t1** command. The output from this command enables you to determine when and where errors occur. See the display field "`Data in current interval`."

```
hq-sanjose# show controller t1
T1 0 is up.
  No alarms detected.
  Version info of slot 0:  HW: 2, Firmware: 16, PLD Rev: 0
Manufacture Cookie Info:
 EEPROM Type 0x0001, EEPROM Version 0x01, Board ID 0x42,
 Board Hardware Version 1.0, Item Number 73-2217-4,
 Board Revision A0, Serial Number 07557185,
 PLD/ISP Version 0.0, Manufacture Date 17-Dec-1997.
  Framing is ESF, Line Code is B8ZS, Clock Source is Line Primary.
  Data in current interval (25 seconds elapsed):
     0 Line Code Violations, 0 Path Code Violations
     0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins
     0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs, 0 Unavail Secs
  Total Data (last 24 hours)
     0 Line Code Violations, 0 Path Code Violations,
     0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins,
     0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs, 0 Unavail Secs
T1 1 is up.
  No alarms detected.
  Version info of slot 0:  HW: 2, Firmware: 16, PLD Rev: 0
Manufacture Cookie Info:
 EEPROM Type 0x0001, EEPROM Version 0x01, Board ID 0x42,
 Board Hardware Version 1.0, Item Number 73-2217-4,
 Board Revision A0, Serial Number 07557185,
 PLD/ISP Version 0.0, Manufacture Date 17-Dec-1997.
  Framing is ESF, Line Code is B8ZS, Clock Source is Line Secondary.
  Data in current interval (827 seconds elapsed):
     0 Line Code Violations, 0 Path Code Violations
     0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins
     0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs, 0 Unavail Secs
  Total Data (last 24 hours)
     0 Line Code Violations, 0 Path Code Violations,
     0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins,
     0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs, 0 Unavail Secs
T1 2 is administratively down.
  Transmitter is sending remote alarm.
  Receiver has loss of signal.
  Version info of slot 0:  HW: 2, Firmware: 16, PLD Rev: 0
Manufacture Cookie Info:
 EEPROM Type 0x0001, EEPROM Version 0x01, Board ID 0x42,
 Board Hardware Version 1.0, Item Number 73-2217-4,
 Board Revision A0, Serial Number 07557185,
 PLD/ISP Version 0.0, Manufacture Date 17-Dec-1997.
  Framing is ESF, Line Code is B8ZS, Clock Source is Internal.
  Data in current interval (868 seconds elapsed):
     3 Line Code Violations, 0 Path Code Violations
     0 Slip Secs, 868 Fr Loss Secs, 2 Line Err Secs, 0 Degraded Mins
     0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs, 868 Unavail Secs
  Total Data (last 24 hours)
     182 Line Code Violations, 0 Path Code Violations,
     1 Slip Secs, 86400 Fr Loss Secs, 125 Line Err Secs, 0 Degraded Mins,
     0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs, 86400 Unavail Secs
T1 3 is administratively down.
  Transmitter is sending remote alarm.
  Receiver has loss of signal.
  Version info of slot 0:  HW: 2, Firmware: 16, PLD Rev: 0
Manufacture Cookie Info:
```

```
 EEPROM Type 0x0001, EEPROM Version 0x01, Board ID 0x42,
 Board Hardware Version 1.0, Item Number 73-2217-4,
 Board Revision A0, Serial Number 07557185,
 PLD/ISP Version 0.0, Manufacture Date 17-Dec-1997.
  Framing is ESF, Line Code is B8ZS, Clock Source is Internal.
  Data in current interval (142 seconds elapsed):
     0 Line Code Violations, 0 Path Code Violations
     0 Slip Secs, 142 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins
     0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs, 142 Unavail Secs
  Total Data (last 24 hours)
     12 Line Code Violations, 0 Path Code Violations,
     0 Slip Secs, 86400 Fr Loss Secs, 8 Line Err Secs, 0 Degraded Mins,
     0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs, 86400 Unavail Secs
```

- Enter the **show controller t1** *number* command. If counters are increasing on a specific T1 controller, look more closely at the error statistics. Error counters are recorded for a 24-hour period in 15-minute intervals. You must specify a specific controller number to see this detailed information. Focus on the current interval.

  In the following example, notice that the frame loss and line errors present in data intervals 1 through 4 were eventually cleared up in the current data interval.

Note Errors are reported to the controller's counters each time an error is encountered. Therefore, clear the counters using the **clear controller t1** *number* command before you look for current error statistics. Error counters stop increasing when the controller is configured correctly.

```
hq-sanjose# show controller t1 0
T1 0 is up.
  No alarms detected.
  Version info of slot 0:  HW: 2, Firmware: 16, PLD Rev: 0
Manufacture Cookie Info:
 EEPROM Type 0x0001, EEPROM Version 0x01, Board ID 0x42,
 Board Hardware Version 1.0, Item Number 73-2217-4,
 Board Revision A0, Serial Number 07557185,
 PLD/ISP Version 0.0, Manufacture Date 17-Dec-1997.
  Framing is ESF, Line Code is B8ZS, Clock Source is Line Primary.
  Data in current interval (72 seconds elapsed):
     0 Line Code Violations, 0 Path Code Violations
     0 Slip Secs, 0 Fr Loss Secs, 0 Line Err Secs, 0 Degraded Mins
     0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs, 0 Unavail Secs
  Data in Interval 1:
     0 Line Code Violations, 0 Path Code Violations
     0 Slip Secs, 405 Fr Loss Secs, 14 Line Err Secs, 0 Degraded Mins
     0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs, 405 Unavail Secs
  Data in Interval 2:
     0 Line Code Violations, 0 Path Code Violations
     0 Slip Secs, 450 Fr Loss Secs, 1 Line Err Secs, 0 Degraded Mins
     0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs, 450 Unavail Secs
  Data in Interval 3:
     0 Line Code Violations, 0 Path Code Violations
     0 Slip Secs, 450 Fr Loss Secs, 1 Line Err Secs, 0 Degraded Mins
     0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs, 450 Unavail Secs
  Data in Interval 4:
     0 Line Code Violations, 0 Path Code Violations
     0 Slip Secs, 450 Fr Loss Secs, 2 Line Err Secs, 0 Degraded Mins
     0 Errored Secs, 0 Bursty Err Secs, 0 Severely Err Secs, 450 Unavail Secs
-------------------------------- snip -----------------------------------------
```

- Enter the **show running** command:

```
hq-sanjose# show running
Building configuration...
Current configuration:
!
----- snip ----
!
isdn switch-type primary-ni
!
controller T1 0
 framing esf
 clock source line primary
 linecode b8zs
 pri-group timeslots 1-24
!
controller T1 1
 framing esf
 clock source line secondary
 linecode b8zs
 pri-group timeslots 1-24
!
controller T1 2
 framing esf
 clock source internal
 linecode b8zs
 pri-group timeslots 1-24
!
controller T1 3
 framing esf
 clock source internal
 linecode b8zs
 pri-group timeslots 1-24
!
----- snip ----
```

Tips

If you have trouble:

- Make sure the controller reports “up.”
- No errors should be reported in the current interval.

Step 5—Configuring the Serial Channels to Let Modem Calls Come in

The async shell service is the first service to enable. Configure the D channels to allow incoming voice calls to be routed to the integrated modems.

In the section “Configuration DDR,” the D channel configuration is expanded to also accept ISDN synchronous PPP calls from the remote offices. Cisco recommends getting modem users up first.

Configure

To configure the serial channels, use the following commands beginning in global configuration mode:

Step	Command	Purpose
1	`hq-sanjose(config)# interface serial 0:23`	Enter configuration mode for the D-channel serial interface that corresponds to controller T1 0[1]. The behavior of S0:0 through S0:22 is controlled by the configuration instructions provided for S0:23. This concept is also true for the other remaining D channel configurations.
2	`hq-sanjose(config-if)# isdn incoming-voice modem` `hq-sanjose(config-if)# no shutdown`	Enable analog modem voice calls coming in over the B channels to be connected to the integrated modems.
3	`hq-sanjose(config-if)# exit`	Exit back to global configuration mode.

4	`hq-sanjose(config)# interface serial 1:23`
	`hq-sanjose(config-if)# isdn incoming-voice modem`
	`hq-sanjose(config-if)# no shutdown`
	`hq-sanjose(config-if)# exit`
	`hq-sanjose(config)# interface serial 2:23`
	`hq-sanjose(config-if)# isdn incoming-voice modem`
	`hq-sanjose(config-if)# no shutdown`
	`hq-sanjose(config-if)# exit`
	`hq-sanjose(config)# interface serial 3:23`
	`hq-sanjose(config-if)# isdn incoming-voice modem`
	`hq-sanjose(config-if)# no shutdown`
	`hq-sanjose(config-if)# exit`
	`hq-sanjose(config)#`
		Configure the three remaining D channels with the same settings.

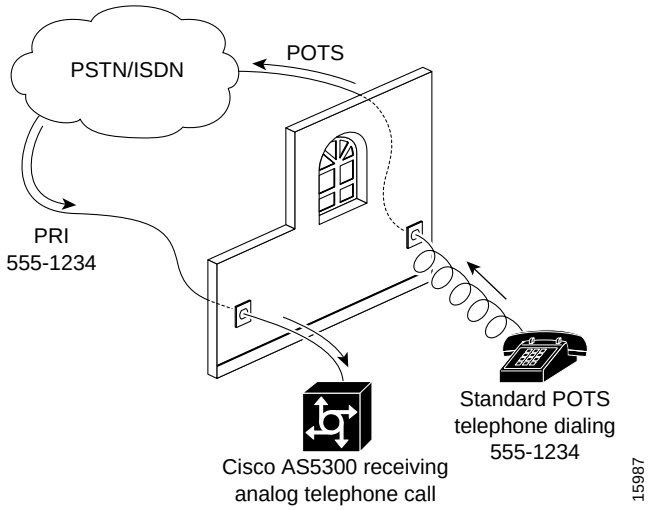
1. The D channel is the signaling channel.

Verify

To verify the configuration:

- Launch a voice call into the access server using a standard POTS telephone. If you hear modem squelch (tone) from the access server's internal modem, the configuration works. See Figure 2-2.

Figure 2-2 Voice Test Call



- Enter the **show interface serial 0:23** command. The term "spoofing" means that the interface is presenting itself to the Cisco IOS software as up and operational. This interface can now receive routes. There are 23 more channels behind this interface that you do not see (for example, S0:0, S0:1, and so on). The D channel decides which serial channel to assign to an incoming call.

```
hq-sanjose# show interface serial 0:23
Serial0:23 is up, line protocol is up (spoofing)
  Hardware is DSX1
  MTU 1500 bytes, BW 64 Kbit, DLY 20000 usec, rely 255/255, load 1/255
  Encapsulation PPP, loopback not set
  DTR is pulsed for 1 seconds on reset
  Last input 00:00:12, output 00:00:12, output hang never
  Last clearing of "show interface" counters never
  Input queue: 0/75/0 (size/max/drops); Total output drops: 0
  Queueing strategy: weighted fair
  Output queue: 0/1000/64/0 (size/max total/threshold/drops)
     Conversations  0/1/256 (active/max active/max total)
     Reserved Conversations 0/0 (allocated/max allocated)
     5 minute input rate 0 bits/sec, 0 packets/sec
     5 minute output rate 0 bits/sec, 0 packets/sec
     937 packets input, 19612 bytes, 0 no buffer
     Received 0 broadcasts, 0 runts, 2 giants, 0 throttles
     2 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     945 packets output, 4263 bytes, 0 underruns
     0 output errors, 0 collisions, 4 interface resets
     0 output buffer failures, 0 output buffers swapped out
     3 carrier transitions
  Timeslot(s) Used:24, Transmitter delay is 0 flags
```

Note The packet counters shown by the **interface serial 0:23** command are for signaling traffic only. Data traffic passes through S0:0 through S0:22.

- Enter the **show isdn status** command to view the ISDN layer information. This output shows that layer 1 and layer 2 are enabled and active. Layer 3 shows the number of active ISDN calls, which there are none currently.

```
hq-sanjose# show isdn status
The current ISDN Switchtype = primary-ni
ISDN Serial0:23 interface
    Layer 1 Status:
        ACTIVE
    Layer 2 Status:
        TEI = 0, State = MULTIPLE_FRAME_ESTABLISHED
    Layer 3 Status:
        No Active Layer 3 Call(s)
    Activated dsl 0 CCBs = 0
    Total Allocated ISDN CCBs = 0
ISDN Serial1:23 interface
    Layer 1 Status:
        ACTIVE
    Layer 2 Status:
        TEI = 0, State = MULTIPLE_FRAME_ESTABLISHED
    Layer 3 Status:
        No Active Layer 3 Call(s)
    Activated dsl 1 CCBs = 0
    Total Allocated ISDN CCBs = 0
ISDN Serial2:23 interface
    Layer 1 Status:
        ACTIVE
    Layer 2 Status:
        TEI = 0, State = MULTIPLE_FRAME_ESTABLISHED
    Layer 3 Status:
        No Active Layer 3 Call(s)
    Activated dsl 2 CCBs = 0
    Total Allocated ISDN CCBs = 0
ISDN Serial3:23 interface
    Layer 1 Status:
        ACTIVE
    Layer 2 Status:
        TEI = 0, State = MULTIPLE_FRAME_ESTABLISHED
    Layer 3 Status:
        No Active Layer 3 Call(s)
    Activated dsl 3 CCBs = 0
    Total Allocated ISDN CCBs = 0
```

  Note the following information:

  — Layer 1 Status should be “Active.”

  — Layer 2 Status should be “Multiple_Frame_Established.” (It might take several seconds for Layer 2 status to appear.)

  — Layer 3 Status should be “No Active Layer 3 Call(s).”

- Enter the **show isdn service** command to determine which channels have active calls and if all the individual channels are in service. In this example notice there are 8 serial channels under each D channel that calls cannot use. T1 lines are used in this case study (not E1).

```
hq-sanjose# show isdn service
PRI Channel Statistics:
ISDN Se0:23, Channel (1-31)
  Activated dsl 0
  State (0=Idle 1=Propose 2=Busy 3=Reserved 4=Restart 5=Maint)
  0 0 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3 3 3 3 3 3 3
  Channel (1-31) Service (0=Inservice 1=Maint 2=Outofservice)
  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 2 2 2 2 2 2
ISDN Se1:23, Channel (1-31)
```

```
  Activated dsl 0
  State (0=Idle 1=Propose 2=Busy 3=Reserved 4=Restart 5=Maint)
  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3 3 3 3 3 3 3 3
  Channel (1-31) Service (0=Inservice 1=Maint 2=Outofservice)
  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 2 2 2 2 2 2 2
ISDN Se2:23, Channel (1-31)
  Activated dsl 0
  State (0=Idle 1=Propose 2=Busy 3=Reserved 4=Restart 5=Maint)
  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3 3 3 3 3 3 3 3
  Channel (1-31) Service (0=Inservice 1=Maint 2=Outofservice)
  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 2 2 2 2 2 2 2
ISDN Se3:23, Channel (1-31)
  Activated dsl 0
  State (0=Idle 1=Propose 2=Busy 3=Reserved 4=Restart 5=Maint)
  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 3 3 3 3 3 3 3 3
  Channel (1-31) Service (0=Inservice 1=Maint 2=Outofservice)
  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 2 2 2 2 2 2 2
```

- Enter the **show ip interface brief** command to view the individual serial B channel interfaces. In the following example, Serial 0:0 through Serial 0:22 are B channels and associated to Serial 0:23.

```
hq-sanjose# show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
Ethernet0              unassigned      YES NVRAM  administratively down down
FastEthernet0          10.1.1.10       YES manual up                    up
Serial0:0              unassigned      YES unset  down                  down
Serial0:1              unassigned      YES unset  down                  down
Serial0:2              unassigned      YES unset  down                  down
Serial0:3              unassigned      YES unset  down                  down
Serial0:4              unassigned      YES unset  down                  down
Serial0:5              unassigned      YES unset  down                  down
Serial0:6              unassigned      YES unset  down                  down
Serial0:7              unassigned      YES unset  down                  down
Serial0:8              unassigned      YES unset  down                  down
Serial0:9              unassigned      YES unset  down                  down
Serial0:10             unassigned      YES unset  down                  down
Serial0:11             unassigned      YES unset  down                  down
Serial0:12             unassigned      YES unset  down                  down
Serial0:13             unassigned      YES unset  down                  down
Serial0:14             unassigned      YES unset  down                  down
Serial0:15             unassigned      YES unset  down                  down
Serial0:16             unassigned      YES unset  down                  down
Serial0:17             unassigned      YES unset  down                  down
Serial0:18             unassigned      YES unset  down                  down
Serial0:19             unassigned      YES unset  down                  down
Serial0:20             unassigned      YES unset  down                  down
Serial0:21             unassigned      YES unset  down                  down
Serial0:22             unassigned      YES unset  down                  down
Serial0:23             unassigned      YES unset  down                  down
```

- Enter the **show running** command:

```
hq-sanjose# show running
Building configuration...
Current configuration:
!
---- snip ----
!
interface Serial0:23
 no ip address
 no ip directed-broadcast
 isdn incoming-voice modem
```

```
!
interface Serial1:23
 no ip address
 no ip directed-broadcast
 isdn incoming-voice modem
!
interface Serial2:23
 no ip address
 no ip directed-broadcast
 isdn incoming-voice modem
!
interface Serial3:23
 no ip address
 no ip directed-broadcast
 isdn incoming-voice modem
!
---- snip ----
```

Tips

If you have trouble:

- Be sure you have the correct ISDN switch type configured.
- Make sure no wires or cables are loose.
- The framing or line code types you entered might not match your telco's settings. A Layer 2 error indicates that the access server cannot communicate with the telco.
- Make sure the **show controller t1** command's current output shows no errors occurring.

Step 6—Configuring the Modems and Lines

Modems and lines are configured after the ISDN channels are operational, and voice calls are successfully routed to the modems. Each modem is directly mapped to a dedicated async line in the access server. After this configuration is set up, the access server is ready to take modem calls.

The modem speed 115200 bps and hardware flow control are the defaults for integrated modems.

Configure

To configure the modems and asynchronous lines, use the following commands beginning in global configuration mode:

Step	Command	Purpose
1	`hq-sanjose(config)# line 1 96`	Enter the range of modem lines to configure. In this example, the access server has 96 integrate modems.
2	`hq-sanjose(config-line)# autoselect ppp` `hq-sanjose(config-line)# autoselect during-login`	Enable remote PPP users to dial in, bypass the EXEC facility, and automatically launch PPP on the line.[1] Enter the **autoselect during-login** command to display the username:password prompt after modems connect.
3	`hq-sanjose(config-line)# modem inout`	Support incoming and outgoing modem calls.

1. These two autoselect commands provide for transparent launching of shell and PPP services on the same lines.

Verify

Enter the **show running** command to verify the configuration:

```
hq-sanjose# show running
Building configuration...
Current configuration:

---- snip ----
!
line 1 96
 autoselect during-login
 autoselect ppp
 modem InOut
---- snip ----
```

Step 7—Testing Async Shell Connections

Now you are ready to send the first modem call into the Cisco AS5300. This step shows you how to perform the test and track the async data path taken by a single modem call.

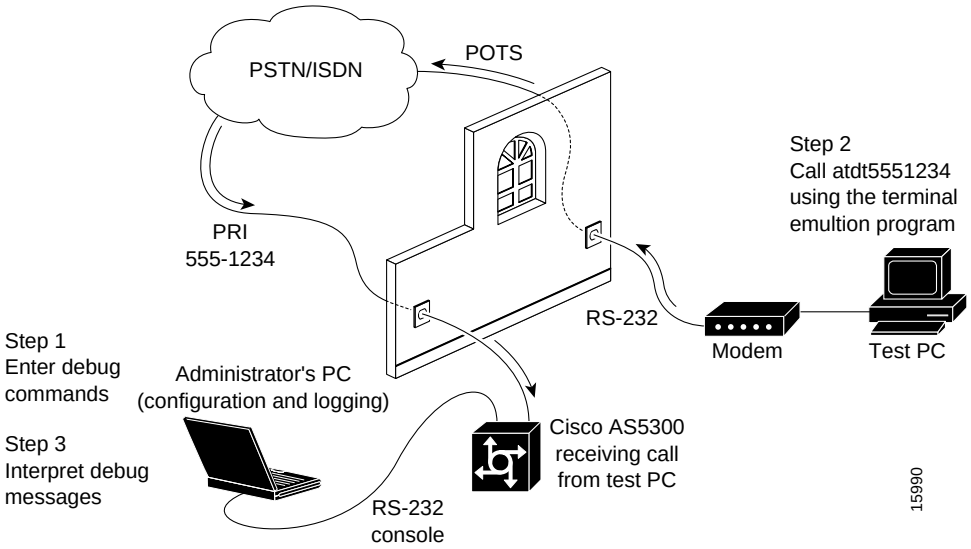
Conduct this test using a shell service, which verifies that the physical async data path is working. This is the most efficient way to get quick test results in a simple test environment.

At this step, many administrators try to make complex services work such as PPP-based Web browsing. Do not jump ahead. Many other elements still need to be configured. This step is provided to ensure that the basic modem link is functioning and that the shell/EXEC prompt can be accessed from a remote location. To avoid problems, take a layered approach to building a network.

Note To enhance readability of debug output messages, the significant display output fields are highlighted with **bold** font.

Figure 2-3 shows the test lab environment used for this test case. The test PC is running a terminal emulation program, such as Hyper Terminal. This program enables the test PC to make a modem-to-modem connection with the Cisco AS5300 via the PSTN/ISDN network.

Figure 2-3 Test Lab Environment



Step 1 Enter the following debug commands on the Cisco AS5300 to debug calls landing on the integrated modems. These commands capture the call-switching module and ISDN connection messages. After you are finished with the test, turn off all debugging with the **undebug all** command.

```
hq-sanjose# debug modem csm
Modem Management Call Switching Module debugging is on
hq-sanjose# debug isdn q931
ISDN Q931 packets debugging is on
hq-sanjose# terminal monitor
% Console already monitors
```

Note The ISDN Q.931 messages display call information coming into the access server. The modem call switching module captures the calls getting routed to the internal modems. The terminal monitor ensures that your EXEC session is receiving the logging and debug output.

Step 2 From a terminal emulation program running on the test PC, enter **atdt** followed by the primary rate interface (PRI) phone number assigned to the Cisco AS5300. In this case test, 5551234 is used.

If the modem successfully connects, you will see a connect message followed by the terminal service EXEC login prompt. This is displayed on the test PC.

```
atdt5551234
CONNECT 24000/REL - MNP

User Access Verification
Username: joe-admin
Password: joe-password

hq-sanjose>
```

Note The modem attached to the test PC sends out "`CONNECT 24000/REL - MNP`" The Cisco AS5300 sends out "`User Access Verification`," "`Username:`," and "`Password:`." These messages are confirmation that you have end-to-end async shell connectivity.

Step 3 For educational purposes, look at and interpret the debug messages that appear on the administrator's terminal screen as a result of Step 2. As the modem call came into the access server, this debug output was created.

The following comments apply to the debug output example:

(a) See 20:43:35.906 through 20:43:35.918.
The setup message is received. The bearer capability is a voice call as indicated by 0x8090A2. The calling party number is 5551111, the test PC's phone number. The called party number is 5551234, the access server's dialed hunt group number.

(b) See 20:43:35.938.
Modem 1/1 is assigned to the incoming voice call.

(c) See 20:43:36.754 and 20:43:36.782.
The call successfully connects as indicated by the fields "`TX -> CONNECT`" and "`RX <- CONNECT_ACK`."

(d) See 20:43:36.806.
The integrated modem waits to negotiate carrier with the remote modem.

```
*Mar  1 20:43:35.906: ISDN Se0:23: RX <-  SETUP pd = 8  callref = 0x0001
*Mar  1 20:43:35.906:         Bearer Capability i = 0x8090A2
*Mar  1 20:43:35.910:         Channel ID i = 0xA98381
*Mar  1 20:43:35.914:         Calling Party Number i = '!', 0x80, '5551111'
*Mar  1 20:43:35.918:         Called Party Number i = 0xA1, '5551234'
*Mar  1 20:43:35.934: EVENT_FROM_ISDN::dchan_idb=0x27C878, call_id=0xB, ces=0x1
   bchan=0x0, event=0x1, cause=0x0
*Mar  1 20:43:35.938: VDEV_ALLOCATE: slot 1 and port 1 is allocated.
*Mar  1 20:43:35.938: EVENT_FROM_ISDN:(000B): DEV_INCALL at slot 1 and port 1
*Mar  1 20:43:35.942: CSM_PROC_IDLE: CSM_EVENT_ISDN_CALL at slot 1, port 1
*Mar  1 20:43:35.946: Fast Ringing On at modem slot 1, port 1
*Mar  1 20:43:35.966: ISDN Se0:23: TX ->  CALL_PROC pd = 8  callref = 0x8001
*Mar  1 20:43:35.970:         Channel ID i = 0xA98381
*Mar  1 20:43:35.978: ISDN Se0:23: TX ->  ALERTING pd = 8  callref = 0x8001
*Mar  1 20:43:36.742: Fast Ringing Off at modem slot 1, port 1
*Mar  1 20:43:36.742: CSM_PROC_IC1_RING: CSM_EVENT_MODEM_OFFHOOK at slot 1, port
 1
*Mar  1 20:43:36.754: ISDN Se0:23: TX ->  CONNECT pd = 8  callref = 0x8001
*Mar  1 20:43:36.782: ISDN Se0:23: RX <-  CONNECT_ACK pd = 8  callref = 0x0001
*Mar  1 20:43:36.798: EVENT_FROM_ISDN::dchan_idb=0x27C878, call_id=0xB, ces=0x1
   bchan=0x0, event=0x4, cause=0x0
*Mar  1 20:43:36.802: EVENT_FROM_ISDN:(000B): DEV_CONNECTED at slot 1 and port 1
*Mar  1 20:43:36.806: CSM_PROC_IC4_WAIT_FOR_CARRIER: CSM_EVENT_ISDN_CONNECTED at
 slot 1, port 1
```

Every Q.931 message indicates whether the message was transmitted by the access server (`TX ->`) or received by the access server (`RX <-`). Table 2-2 shows the most common message types used for opening and closing connections. Information elements exist within each message type, as described in Table 2-3.

Table 2-2 Debug Q.931 ISDN Messages

Message Type	Description
`SETUP`	Indicates that a SETUP message has been received to initiate call establishment between PSTN end devices. A key element to observe within the call setup message is the bearer capability.
`CALL_PROC`	Call proceeding. The network attempts to service the call. The switch is attempting to set up a call through the ISDN network backbone.
`CONNECT`	The called side transmits "`CONNECT`" when the connection is made. The side that transmits "`CONNECT`" is usually the side that receives the call, which is the called party.
`CONNECT_ACK`	Connect acknowledgment. Transmitted by the calling side to indicate that the "`CONNECT`" message was received.
`DISCONNECT`	Indicates that the transmitting side is ending the call. This messages indicates who dropped the call.
`RELEASE`	Indicates that the sending equipment is releasing the call and the associated channel.
`RELEASE_COMP`	Release complete. Indicates that the ISDN network has received the "`RELEASE`" message.

ISDN setup messages contain different information elements. See Table 2-3.

Table 2-3 Information Elements within an ISDN Setup Message

Message	Description
`Bearer Capability`	Indicates what kind of service the caller is requesting. For example, a 64K data call is indicated by the bearer capability of 0x8890. An analog voice call is indicated by the value 0x8090A2.
`pd`	Indicates the protocol discriminator number, which is 8 for Q.931 messages.
`callref`	A number used by the access server and the switch to reference the call. Indicates the call reference number in hexadecimal format. The field value indicates the number of calls made from the router (outgoing calls) or the network (incoming calls). Note that the originator of the SETUP message sets the high-order bit of the call reference number to 0. The destination of the connection sets the high-order bit to 1 in subsequent call control messages, such as the `CONNECT` message. For example, callref = 0x04 in the request becomes callref = 0x84 in the response.
`Cause i`	Indicates the Information Element Identifier. The value depends on the field with which it is associated. Refer to the ITU-T Q.931 specification for details about the possible values associated with each field for which this identifier is relevant.
`Channel ID`	Indicates the Channel Identifier. The value 83 indicates any channel, 89 indicates the B1 channel, and 8A indicates the B2 channel. For more information about the Channel Identifier, refer to ITU-T Recommendation Q.931.
`Calling Party Number`	Identifies the phone number of the device that initiated the call. In this case study, 5551111 is the directory number assigned to the telephone line used by the test PC.

Table 2-3 Information Elements within an ISDN Setup Message (Continued)

Message	Description
Called Party Number	Identifies the called phone number that is used to reach another device. In this case study, 5551234 is the directory number assigned to the Cisco AS5300. The test PC dialed this number to make a modem connection.

Step 4 To determine the status of the modem call connected to the Cisco AS5300, use the following modem management commands.

- Enter the **show user** command to see which TTY line the call landed on:

```
hq-sanjose# show user
    Line     User         Host(s)                 Idle Location
*  0 con 0   joe-admin    idle                    0
   2 tty 2   joe-admin    Async interface         1
```

- Enter the **show line 2** command. Note that TTY 2 is associated with modem 1/1. The state is currently idle because this command was entered after the user disconnected.

```
hq-sanjose# show line 2
  Tty Typ     Tx/Rx     A Modem  Roty AccO AccI  Uses    Noise   Overruns
   2 TTY 115200/115200 - inout     -    -    -     0        0        0/0

Line 2, Location: "", Type: ""
Length: 24 lines, Width: 80 columns
Baud rate (TX/RX) is 115200/115200, no parity, 1 stopbits, 8 databits
Status: No Exit Banner
Capabilities: Hardware Flowcontrol In, Hardware Flowcontrol Out
  Modem Callout, Modem RI is CD
  Modem state: Idle
  modem(slot/port)=1/1, state=IDLE
  dsx1(slot/unit/channel)=NONE, status=VDEV_STATUS_UNLOCKED
Group codes:    0
Modem hardware state: CTS noDSR  DTR RTS
Special Chars: Escape  Hold  Stop  Start  Disconnect  Activation
                ^^x    none   -     -       none
Timeouts:      Idle EXEC    Idle Session   Modem Answer  Session   Dispatch
               00:10:00        never                       none     not set
                            Idle Session Disconnect Warning
                              never
                            Login-sequence User Response
                             00:00:30
                            Autoselect Initial Wait
   Tty Typ     Tx/Rx     A Modem  Roty AccO AccI  Uses    Noise   Overruns
                              not set
Modem type is unknown.
Session limit is not set.
Time since activation: never
Editing is enabled.
History is enabled, history size is 10.
DNS resolution in show commands is enabled
Full user help is disabled
Allowed transports are lat pad telnet rlogin v120.  Preferred is lat.
No output characters are padded
No special data dispatching characters
```

- Enter the **show modem log 1/1** command to view the information logged for modem 1/1. The time stamps show when the event occurred. The most current events begin at the bottom of the output.

```
hq-sanjose# show modem log 1/1
Modem 1/1 Events Log:
  20:40:45: Startup Response: Microcom (Managed)
            Modem (boot) firmware = 2.2(8) (1.0(5))
  ---- snip ----
  00:02:19: ISDN incoming calling number: 5551111
  00:02:19: ISDN incoming called number: 5551234
  00:02:13: Modem State event: Dialing/Answering
  00:02:13: Modem State event: Incoming ring
  00:02:13: Modem State event: Waiting for Carrier
  00:02:13: RS232 event: RTS  DTR  CTS  DSR  noDCD  noRI* noTST
  00:02:01: Modem State event: Connected
  00:02:01: Connection event: TX/RX Speed = 33600/33600, Modulation = V34
            Direction = Answer, Protocol = reliable/LAPM, Compression = V42bis
  00:02:02: RS232 event: RTS  DTR  CTS  DSR  DCD* noRI  noTST
  00:01:50: Modem Analog signal event: TX = -21, RX = -18, Signal to noise = 43
  00:00:15: DTR event: DTR Off
  00:00:15: Modem State event: Connected
  00:00:15: End connection event: Retransmits for EC block (TX/RX) = 0/0
            Duration = 0:01:43, Number of TX/RX char = 159/0
            Local Disc Reason = DTR Drop
            Remote Disc Reason = Unknown
  00:00:15: Modem State event: Disconnecting
  00:00:15: DTR event: DTR On
  00:00:15: RS232 event: RTS  DTR* CTS* DSR* noDCD* noRI* noTST*
```

- Enter the **show modem** command. In the following example, the current active call is on modem 1/1, which is functioning properly at 100%. An active call is indicated by an asterisk (*).

```
hq-sanjose# show modem
              Inc calls     Out calls     Busied   Failed  No       Succ
  Mdm  Usage  Succ   Fail   Succ   Fail   Out      Dial    Answer   Pct.
  1/0     0%     0      0      0      0      0        0       0      0%
* 1/1     0%     1      0      0      0      0        0       0      100%
  1/2     0%     0      0      0      0      0        0       0      0%
  1/3     0%     0      0      0      0      0        0       0      0%
  1/4     0%     0      0      0      0      0        0       0      0%
  1/5     0%     0      0      0      0      0        0       0      0%
  1/6     0%     0      0      0      0      0        0       0      0%
  1/7     0%     0      0      0      0      0        0       0      0%
  1/8     0%     0      0      0      0      0        0       0      0%
  1/9     0%     0      0      0      0      0        0       0      0%
  1/10    0%     0      0      0      0      0        0       0      0%
  1/11    0%     0      0      0      0      0        0       0      0%
---- snip -----
```

- Enter the **show controller t1 0 call-counters** command, which shows you the DS0 timeslot used to carry the modem call. This example shows that timeslot 1 has accepted one call for a total duration of 1 minute 30 seconds.

```
hq-sanjose# show controller t1 0 call-counters
T1 0:
  DS0's Active: 0
  DS0's Active High Water Mark: 0
  TimeSlot   Type   TotalCalls   TotalDuration
      1       pri           1       00:01:30
      2       pri           0       00:00:00
      3       pri           0       00:00:00
      4       pri           0       00:00:00
      5       pri           0       00:00:00
      6       pri           0       00:00:00
      7       pri           0       00:00:00
      8       pri           0       00:00:00
      9       pri           0       00:00:00
     10       pri           0       00:00:00
     11       pri           0       00:00:00
     12       pri           0       00:00:00
     13       pri           0       00:00:00
     14       pri           0       00:00:00
     15       pri           0       00:00:00
     16       pri           0       00:00:00
     17       pri           0       00:00:00
     18       pri           0       00:00:00
     19       pri           0       00:00:00
     20       pri           0       00:00:00
     21       pri           0       00:00:00
     22       pri           0       00:00:00
     23       pri           0       00:00:00
Total DS0's Active High Water Mark: 0
```

- To further troubleshoot modem problems, connect to a modem's out-of-band management port. For Microcom modems, use the **modem at-mode** *slot*/*port* command. For MICA modems, use the **show modem operational-status** *slot*/*port* command and the **show modem configuration** *slot*/*port* command.

```
hq-sanjose# modem at-mode 2/15
You are now entering AT command mode on modem (slot 2 / port 15).
Please type CTRL-C to exit AT command mode.
at@e1


MNP Class 10 K56flex Modem
MODEM HW: OEM 2W United States
Firmware Rev 3.3.20/85
Bootstrap Rev 3.0.4
DSP C36 Part/Rev              3635 4241
DSP C58 Part/Rev              3635 2041
DSP Controller Rev            42
DSP Data Pump Rev             4.2
NET ADDR:      FFFFFFFFFFFF
Connect Time                  000:06:41
4 RTS 5 CTS 6 DSR 8 CD 20 DTR - RI
Disconnect  Remote -   Local -

Mod Type                      V.34
TX/RX Spd                     24000  26400 BPS
TX/RX Spd Mask                   NA  BFFF Hex
Symbol Rate                   3200 Hz
TX/RX Carrier Freq            1829  1829 Hz
TX/RX States                    16    16
TX/RX NLE                       ON    ON
TX/RX Precoding                 ON    ON
TX/RX Shaping                   ON    ON
TX Preemphasis Index             0

TX Lvl REG                    - 13 dBm
TX Lvl RAM                    -  0 dB
TX Lvl Reduct                    1 dB
TX Lvl                        - 14 dBm
RX Lvl                        - 19 dBm
S/NR                            42
S/DR                             0
EQM                           1C00 Hex
AVG EQM                       19BE Hex
Lower/Upper Edge               150  3675 Hz
Phase Jitter Freq              139 Hz
Phase Jitter Amp               0.0 deg
Far Echo Lvl                   138 N
Round Trip Delay                 0 msec
Dropouts > 5dB                   0
RTRNs Init/Accept                0     0
RRENs Init/Accept                0     0
BLER                          0000 Hex
RBS Counter                   0000 Hex
Digital Pad Detected          0 dB
Max SECRXB                    67
Max SECTXB                    67
V8BIS STATUS                  NAK

OK
```

Step 8—Setting Up IP Address Pools

Create a pool of IP address to support remote nodes dialing in. As remote node devices connect, they request an IP address from the central site.

It is important to determine how your intranet/Internet backbone will route packets to the addresses in this pool. There are several ways to do this, such as using addresses off a subnet defined on the access server (for example, on the loopback or Ethernet interface).

Note Administrators commonly create a loopback interface and new subnet if their existing Ethernet subnet has all its IP addresses already consumed. Loopback interfaces are very stable and do not go up and down as LAN interfaces may.

Configure

To set up the address pool, use the following commands beginning in global configuration mode:

Step	Command	Purpose
1	`hq-sanjose(config)# interface loopback 0`	Create loopback interface 0.
2	`hq-sanjose(config-if)# ip address 10.1.2.1 255.255.255.0`	Assign an IP subnet and address to loopback 0. This subnet is used for the creation of your IP address pool[1].
3	`hq-sanjose(config-if)# exit`	Exit back to global configuration mode.
4	`hq-sanjose(config)# ip local pool dialin_pool 10.1.2.2 10.1.2.97`	Create a pool of IP addresses for assigning to the remote nodes[2].
5	`hq-sanjose(config)# async-bootp dns-server 10.2.2.3 10.2.3.1`	Specify the domain name servers on the network, which can be used for clients dialing in with PPP.

1. This subnet is now dedicated to this Cisco AS5300 for remote node support. This subnet cannot be used in other places in your network.
2. A remote LAN is typically a router that has a next hop address and its own IP subnet. It also requires IP routing support from the backbone, which is commonly accomplished with a static IP route. A remote node gets an IP address out of a central pool of IP addresses. Remote LANs and remote nodes are primarily differentiated by this IP addressing scheme. Remote LANs can appear as remote nodes by using PAT.

Verify

Enter the **show ip local pool** command to verify the configuration:

```
hq-sanjose# show ip local pool
 Pool         Begin           End             Free    In use   Cache Size
 dialin_pool  10.1.2.2        10.1.2.97         96       0          20
```

Step 9—Configuring the Group-Async Interface

The group-async interface is a template, which is used to control the configuration of all the async interfaces on the access server. Async interfaces are lines that are running in PPP mode. An async interface uses the same number as its corresponding line. Configuring the asynchronous interfaces as a group-async saves you time and configuration file size.

Configure

To configure the group-async interface, use the following commands beginning in global configuration mode:

Step	Command	Purpose
1	`hq-sanjose(config)# interface group-async 1`	Create the group-async interface.
2	`hq-sanjose(config-if)# ip unnumbered loopback 0`	To conserve IP address space, configure the asynchronous interfaces as unnumbered.
3	`hq-sanjose(config-if)# encapsulation ppp`	Enable PPP.
4	`hq-sanjose(config-if)# async mode interactive`	Configure interactive mode on the asynchronous interfaces. Interactive means that users can dial in and get to a shell or PPP session on that line.
5	`hq-sanjose(config-if)# ppp authentication chap pap`	Enable CHAP and PAP authentication on the interface during LCP negotiation. The access server first requests to authenticate with CHAP. If CHAP is rejected by the remote client (modem), then PAP authentication is requested.
6	`hq-sanjose(config-if)# peer default ip address pool dialin_pool`	Assign dial-in clients IP addresses from the pool named dialin_pool.
7	`hq-sanjose(config-if)# no cdp enable`	Disable the Cisco discovery protocol.
8	`hq-sanjose(config-if)# group-range 1 96`	Specify the range of asynchronous interfaces to include in the group, which is usually equal to the number of modems you have in the access server.

Verify

Enter the **show running** command. After completing Steps 1 through 9, the configuration looks like this:

```
hq-sanjose# show running
Building configuration...
Current configuration:
!
version 12.0
service timestamps debug datetime msec
service timestamps log datetime msec
service password-encryption
!
hostname hq-sanjose
!
aaa new-model
aaa authentication login default local
```

```
aaa authentication ppp default if-needed local
enable secret 5 $1$.voA$9/8.Zoil3jeWJMP6hEE6U0
!
username joe-admin password 7 <removed>
!
async-bootp dns-server 10.2.2.3 10.2.3.1
isdn switch-type primary-ni
!
!
controller T1 0
 framing esf
 clock source line primary
 linecode b8zs
 pri-group timeslots 1-24
!
controller T1 1
 framing esf
 clock source line secondary
 linecode b8zs
 pri-group timeslots 1-24
!
controller T1 2
 framing esf
 clock source internal
 linecode b8zs
 pri-group timeslots 1-24
!
controller T1 3
 framing esf
 clock source internal
 linecode b8zs
 pri-group timeslots 1-24
!
interface Loopback0
 ip address 10.1.2.1 255.255.255.0
 no ip directed-broadcast
!
interface Ethernet0
 no ip address
 no ip directed-broadcast
 no ip route-cache
 no ip mroute-cache
 shutdown
!
interface Serial0:23
 no ip address
 no ip directed-broadcast
 isdn incoming-voice modem
 no fair-queue
 no cdp enable
!
interface Serial1:23
 no ip address
 no ip directed-broadcast
 isdn incoming-voice modem
 no fair-queue
 no cdp enable
!
interface Serial2:23
 no ip address
 no ip directed-broadcast
 isdn incoming-voice modem
 no fair-queue
 no cdp enable
```

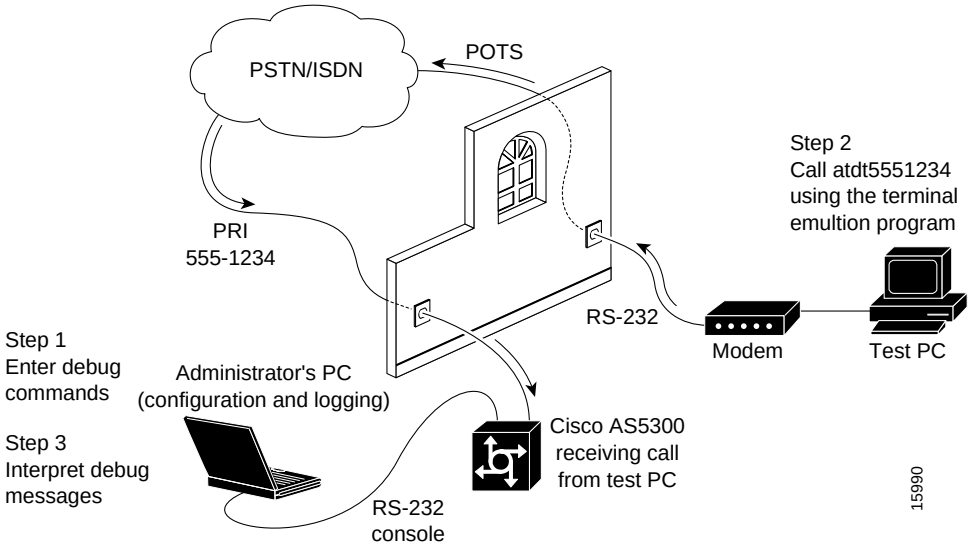
```
!
interface Serial3:23
 no ip address
 no ip directed-broadcast
 isdn incoming-voice modem
 no fair-queue
 no cdp enable
!
interface FastEthernet0
 ip address 10.1.1.10 255.255.255.0
 no ip directed-broadcast
 no ip route-cache
 no ip mroute-cache
 duplex auto
 speed auto
!
interface Group-Async1
 ip unnumbered Loopback0
 no ip directed-broadcast
 encapsulation ppp
 async mode interactive
 peer default ip address pool dialin_pool
 no cdp enable
 ppp authentication chap pap
 group-range 1 96
!
ip local pool dialin_pool 10.1.2.2 10.1.2.97
!
!
line con 0
line 1 96
 autoselect during-login
 autoselect ppp
 modem InOut
line aux 0
line vty 0 4
!
end
```

Step 10—Testing Async PPP Connections

Now you are ready to send the first async PPP modem call into the Cisco AS5300. This step provides you with a picture of the test lab followed by debug output for a successful connection.

Figure 2-3 shows the test lab environment used for this test. A test PC makes a PPP modem-to-modem connection with the Cisco AS5300 via the PSTN/ISDN network.

Figure 2-4 Test Lab Environment



Step 1 Enter the following debugging commands on the Cisco AS5300:

```
hq-sanjose# debug ppp negotiation
PPP protocol negotiation debugging is on
hq-sanjose# debug ppp authentication
PPP authentication debugging is on
hq-sanjose# debug modem
Modem control/process activation debugging is on
hq-sanjose# debug ip peer
IP peer address activity debugging is on

hq-sanjose# show debug
General OS:
  Modem control/process activation debugging is on
Generic IP:
  IP peer address activity debugging is on
PPP:
  PPP authentication debugging is on
  PPP protocol negotiation debugging is on

hq-sanjose# terminal monitor
```

Step 2 From a terminal emulation program running on the test PC, enter **atdt** followed by the telephone number assigned to the Cisco AS5300. In this case test, 5551234 is used.

```
atdt5551234
CONNECT 24000/REL - MNP

User Access Verification
Username: joe-admin
Password: joe-password

hq-sanjose>
```

Step 3 Interpret the debug messages that appear on the administrator's terminal screen as a result of Step 2. As the modem call comes into the access server, debug output is created.

Note When examining PPP between two remote peers, first check to see if both sides get through LCP negotiation. If they do, move on to check authentication. After authentication is successful, check IPCP negotiation.

The following comments apply to the debug output example, which spans over the next few pages. Locate the time stamps in the debug output then interpret the call behavior.

(a) See 21:34:56.958.
A modem call comes into the access server on TTY line 4.

(b) See 21:34:59.722 through 21:34:59.734.
An incoming PPP frame is recognized, so PPP is launched on TTY line 4.

(c) See 21:34:59.790.
The test PC gets assigned an IP address from the address pool set up on the access server. The address is 10.1.2.2.

(d) See 21:35:01.798.
Interface async 4 comes up. After PPP launches, TTY line 4 becomes async interface 4.

(e) See 21:35:02.718.
Incoming config request (I CONFREQ). The remote test PC requests a set of options to be negotiated. The PC asks the Cisco AS5300 to support the callback option.

(f) See 21:35:02.738.
Outgoing config reject (O CONFREJ). The Cisco AS5300 rejects this option, because the access server is not configured to support Microsoft Callback in this case study.

(g) See 21:35:02.850.
Incoming config request (I CONFREQ). The test PC requests a new set of options.

(h) See 21:35:02.862.
Outgoing config acknowledgment (O CONFACK). The Cisco AS5300 accepts the new set of options.

(i) See 21:35:03.978.
LCP is now open (LCP: State is Open). Both sides have acknowledged (CONFACK) the other side's configuration request (CONFREQ).

(j) See 21:35:03.978.
After LCP negotiates, authentication starts. Authentication must happen before any network protocols, such as IP, are delivered. Both sides authenticate with the method negotiated during LCP. The Cisco AS5300 is authenticating the test PC using CHAP. The test PC is not authenticating the access server in this test case.

(k) See 21:35:03.982.
Outgoing challenge from hq-sanjose.

(l) See 21:35:04.162.
Incoming CHAP response from the test PC, which is shows the username joe-admin.

(m) See 21:35:04.182.
An outgoing success is sent from the NAS—authentication is successful.

(n) See 21:35:04.186.
PPP is up. The Cisco AS5300 PPP link is now open and available to negotiate any network protocols supported by both peers.

(o) See 21:35:04.314 through 21:35:04.322.
The test PC requests support for Microsoft Point-to-Point Compression (MPPC). The Cisco AS5300 rejects this request. The access server's integrated modems already support hardware compression, and the Cisco IOS is not configured to support software compression.

(p) See 21:35:07.274 through 21:35:07.478.
The primary and secondary DNS addresses are negotiated. At first, the test PC asks for 0.0.0.0. addresses. The access server sends out a CONFNAK and supplies the correct values. Values include an IP address from the pool, the primary DNS address, and the backup DNS address.

(q) See 21:35:07.426.
The test PC sends an incoming request saying that the new values are accepted. Whenever the access server sends out a CONFNAK that includes values, the test PC still needs to come back and report acceptance of the new values.

(r) See 21:35:07.458 through 21:35:07.490.
An outgoing CONFACK is sent for IPCP. The state is open for IPCP. A route is negotiated for the IPCP peer, which is 10.1.2.2.

Note To enhance readability of debug output messages, significant display output fields are highlighted with **bold** font.

```
hq-sanjose#
*Mar  1 21:34:56.958: TTY4: DSR came up
*Mar  1 21:34:56.962: TTY4: Modem: IDLE->READY
*Mar  1 21:34:56.970: TTY4: EXEC creation
*Mar  1 21:34:56.978: TTY4: set timer type 10, 30 seconds
*Mar  1 21:34:59.722: TTY4: Autoselect(2) sample 7E
*Mar  1 21:34:59.726: TTY4: Autoselect(2) sample 7EFF
*Mar  1 21:34:59.730: TTY4: Autoselect(2) sample 7EFF7D
*Mar  1 21:34:59.730: TTY4: Autoselect(2) sample 7EFF7D23
*Mar  1 21:34:59.734: TTY4 Autoselect cmd: ppp negotiate
*Mar  1 21:34:59.746: TTY4: EXEC creation
*Mar  1 21:34:59.746: TTY4: create timer type 1, 600 seconds
*Mar  1 21:34:59.786: ip_get_pool: As4: using pool default
*Mar  1 21:34:59.790: ip_get_pool: As4: returning address = 10.1.2.2
*Mar  1 21:34:59.794: TTY4: destroy timer type 1 (OK)
*Mar  1 21:34:59.794: TTY4: destroy timer type 0
*Mar  1 21:35:01.798: %LINK-3-UPDOWN: Interface Async4, changed state to up
*Mar  1 21:35:01.834: As4 PPP: Treating connection as a dedicated line
*Mar  1 21:35:01.838: As4 PPP: Phase is ESTABLISHING, Active Open
*Mar  1 21:35:01.842: As4 LCP: O CONFREQ [Closed] id 1 len 25
*Mar  1 21:35:01.846: As4 LCP:    ACCM 0x000A0000 (0x0206000A0000)
*Mar  1 21:35:01.850: As4 LCP:    AuthProto CHAP (0x0305C22305)
*Mar  1 21:35:01.854: As4 LCP:    MagicNumber 0x64E923A8 (0x050664E923A8)
*Mar  1 21:35:01.854: As4 LCP:    PFC (0x0702)
*Mar  1 21:35:01.858: As4 LCP:    ACFC (0x0802)
*Mar  1 21:35:02.718: As4 LCP: I CONFREQ [REQsent] id 3 len 23
*Mar  1 21:35:02.722: As4 LCP:    ACCM 0x000A0000 (0x0206000A0000)
*Mar  1 21:35:02.726: As4 LCP:    MagicNumber 0x00472467 (0x050600472467)
*Mar  1 21:35:02.726: As4 LCP:    PFC (0x0702)
*Mar  1 21:35:02.730: As4 LCP:    ACFC (0x0802)
*Mar  1 21:35:02.730: As4 LCP:    Callback 6  (0x0D0306)
*Mar  1 21:35:02.738: As4 LCP: O CONFREJ [REQsent] id 3 len 7
*Mar  1 21:35:02.738: As4 LCP:    Callback 6  (0x0D0306)
*Mar  1 21:35:02.850: As4 LCP: I CONFREQ [REQsent] id 4 len 20
*Mar  1 21:35:02.854: As4 LCP:    ACCM 0x000A0000 (0x0206000A0000)
*Mar  1 21:35:02.854: As4 LCP:    MagicNumber 0x00472467 (0x050600472467)
*Mar  1 21:35:02.858: As4 LCP:    PFC (0x0702)
*Mar  1 21:35:02.858: As4 LCP:    ACFC (0x0802)
*Mar  1 21:35:02.862: As4 LCP: O CONFACK [REQsent] id 4 len 20
*Mar  1 21:35:02.866: As4 LCP:    ACCM 0x000A0000 (0x0206000A0000)
*Mar  1 21:35:02.870: As4 LCP:    MagicNumber 0x00472467 (0x050600472467)
*Mar  1 21:35:02.870: As4 LCP:    PFC (0x0702)
*Mar  1 21:35:02.874: As4 LCP:    ACFC (0x0802)
*Mar  1 21:35:03.842: As4 LCP: TIMEout: State ACKsent
*Mar  1 21:35:03.842: As4 LCP: O CONFREQ [ACKsent] id 2 len 25
*Mar  1 21:35:03.846: As4 LCP:    ACCM 0x000A0000 (0x0206000A0000)
*Mar  1 21:35:03.850: As4 LCP:    AuthProto CHAP (0x0305C22305)
*Mar  1 21:35:03.854: As4 LCP:    MagicNumber 0x64E923A8 (0x050664E923A8)
*Mar  1 21:35:03.854: As4 LCP:    PFC (0x0702)
*Mar  1 21:35:03.858: As4 LCP:    ACFC (0x0802)
*Mar  1 21:35:03.962: As4 LCP: I CONFACK [ACKsent] id 2 len 25
*Mar  1 21:35:03.966: As4 LCP:    ACCM 0x000A0000 (0x0206000A0000)
*Mar  1 21:35:03.966: As4 LCP:    AuthProto CHAP (0x0305C22305)
*Mar  1 21:35:03.970: As4 LCP:    MagicNumber 0x64E923A8 (0x050664E923A8)
*Mar  1 21:35:03.974: As4 LCP:    PFC (0x0702)
*Mar  1 21:35:03.974: As4 LCP:    ACFC (0x0802)
*Mar  1 21:35:03.978: As4 LCP: State is Open
*Mar  1 21:35:03.978: As4 PPP: Phase is AUTHENTICATING, by this end
*Mar  1 21:35:03.982: As4 CHAP: O CHALLENGE id 1 len 26 from "hq-sanjose"
```

```
*Mar  1 21:35:04.162: As4 CHAP: I RESPONSE id 1 len 26 from "joe-admin"
*Mar  1 21:35:04.170: As4 AUTH: Started process 0 pid 47
*Mar  1 21:35:04.182: As4 CHAP: O SUCCESS id 1 len 4
*Mar  1 21:35:04.186: As4 PPP: Phase is UP
*Mar  1 21:35:04.190: As4 IPCP: O CONFREQ [Not negotiated] id 1 len 10
*Mar  1 21:35:04.194: As4 IPCP:    Address 10.1.2.1 (0x03060A010201)
*Mar  1 21:35:04.282: As4 IPCP: I CONFREQ [REQsent] id 1 len 28
*Mar  1 21:35:04.282: As4 IPCP:    CompressType VJ 15 slots CompressSlotID (0x02
06002D0F01)
*Mar  1 21:35:04.286: As4 IPCP:    Address 0.0.0.0 (0x030600000000)
*Mar  1 21:35:04.290: As4 IPCP:    PrimaryDNS 0.0.0.0 (0x810600000000)
*Mar  1 21:35:04.298: As4 IPCP:    SecondaryDNS 0.0.0.0 (0x830600000000)
*Mar  1 21:35:04.306: As4 IPCP: O CONFREJ [REQsent] id 1 len 10
*Mar  1 21:35:04.310: As4 IPCP:    CompressType VJ 15 slots CompressSlotID (0x02
06002D0F01)
*Mar  1 21:35:04.314: As4 CCP: I CONFREQ [Not negotiated] id 1 len 15
*Mar  1 21:35:04.318: As4 CCP:    MS-PPC supported bits 0x00000001 (0x1206000000
01)
*Mar  1 21:35:04.318: As4 CCP:    Stacker history 1 check mode EXTENDED (0x11050
00104)
*Mar  1 21:35:04.322: As4 LCP: O PROTREJ [Open] id 3 len 21 protocol CCP
*Mar  1 21:35:04.326: As4 LCP:  (0x80FD0101000F12060000000111050001)
*Mar  1 21:35:04.330: As4 LCP:  (0x04)
*Mar  1 21:35:04.334: As4 IPCP: I CONFACK [REQsent] id 1 len 10
*Mar  1 21:35:04.338: As4 IPCP:    Address 10.1.2.1 (0x03060A010201)
*Mar  1 21:35:05.186: %LINEPROTO-5-UPDOWN: Line protocol on Interface Async4, ch
anged state to up
*Mar  1 21:35:07.274: As4 IPCP: I CONFREQ [ACKrcvd] id 2 len 22
*Mar  1 21:35:07.278: As4 IPCP:    Address 0.0.0.0 (0x030600000000)
*Mar  1 21:35:07.282: As4 IPCP:    PrimaryDNS 0.0.0.0 (0x810600000000)
*Mar  1 21:35:07.286: As4 IPCP:    SecondaryDNS 0.0.0.0 (0x830600000000)
*Mar  1 21:35:07.294: As4 IPCP: O CONFNAK [ACKrcvd] id 2 len 22
*Mar  1 21:35:07.298: As4 IPCP:    Address 10.1.2.2 (0x03060A010202)
*Mar  1 21:35:07.302: As4 IPCP:    PrimaryDNS 10.2.2.3 (0x81060A020203)
*Mar  1 21:35:07.310: As4 IPCP:    SecondaryDNS 10.2.3.1 (0x83060A020301)
*Mar  1 21:35:07.426: As4 IPCP: I CONFREQ [ACKrcvd] id 3 len 22
*Mar  1 21:35:07.430: As4 IPCP:    Address 10.1.2.2 (0x03060A010202)
*Mar  1 21:35:07.434: As4 IPCP:    PrimaryDNS 10.2.2.3 (0x81060A020203)
*Mar  1 21:35:07.442: As4 IPCP:    SecondaryDNS 10.2.3.1 (0x83060A020301)
*Mar  1 21:35:07.446: ip_get_pool: As4: validate address = 10.1.2.2
*Mar  1 21:35:07.450: ip_get_pool: As4: using pool default
*Mar  1 21:35:07.450: ip_get_pool: As4: returning address = 10.1.2.2
*Mar  1 21:35:07.454: set_ip_peer_addr: As4: address = 10.1.2.2 (3) is redundant
*Mar  1 21:35:07.458: As4 IPCP: O CONFACK [ACKrcvd] id 3 len 22
*Mar  1 21:35:07.462: As4 IPCP:    Address 10.1.2.2 (0x03060A010202)
*Mar  1 21:35:07.466: As4 IPCP:    PrimaryDNS 10.2.2.3 (0x81060A020203)
*Mar  1 21:35:07.474: As4 IPCP:    SecondaryDNS 10.2.3.1 (0x83060A020301)
*Mar  1 21:35:07.478: As4 IPCP: State is Open
*Mar  1 21:35:07.490: As4 IPCP: Install route to 10.1.2.2

hq-sanjose# undebug all
All possible debugging has been turned off
```

Note After you finish testing, turn off all debugging with the **undebug all** command. Isolating the display of debug output helps you efficiently build a network. Debug only at the components that you have built so far.

Step 11—Configuring DDR

Dial-on-demand routing (DDR) provides a mechanism to establish and maintain connectivity over a circuit switched network, such as the PSTN. DDR also supports remote LANs by maintaining IP routes to the remote sites when they are not connected.

Configure

To configure the dialer interfaces, use the following commands beginning in global configuration mode:

Step	Command	Purpose
1	`hq-sanjose(config)# interface dialer 1` `hq-sanjose(config-if)# ip address 10.1.254.1 255.255.255.0`	Create interface dialer 1 and enable IP routing.
2	`hq-sanjose(config-if)# exit`	Exit back to global configuration mode.

3	`hq-sanjose(config)# interface serial 0:23`
	`hq-sanjose(config-if)# dialer rotary-group 1`
	`hq-sanjose(config-if)# exit`
		Group serial 0's channels into dialer 1.

4	`hq-sanjose(config)# interface serial 1:23`
	`hq-sanjose(config-if)# dialer rotary-group 1`
	`hq-sanjose(config-if)# exit`
	`hq-sanjose(config)# interface serial 2:23`
	`hq-sanjose(config-if)# dialer rotary-group 1`
	`hq-sanjose(config-if)# exit`
	`hq-sanjose(config)# interface serial 3:23`
	`hq-sanjose(config-if)# dialer rotary-group 1`
	`hq-sanjose(config-if)# exit`
		Group the remaining serial channels into dialer 1.

5	`hq-sanjose(config)# interface dialer 1`	Now with all the D channels grouped together, return to dialer 1.
6	`hq-sanjose(config-if)# encapsulation ppp`	Encapsulate the packets with PPP.
7	`hq-sanjose(config-if)# peer default ip address pool dialin_pool`	Assign an address pool to interface dialer 1. This step supports remote node ISDN devices, such as those running Easy IP and PAT[1].
8	`hq-sanjose(config-if)# dialer in-band`	Specify that this is an in-band dialer interface, which enables passing the phone number across the D channel.
9	`hq-sanjose(config-if)# dialer idle-timeout 1800`	Configure the idle timeout, which is set to 1800 seconds (30 minutes) in this example[2].
10	`hq-sanjose(config-if)# dialer-group 2`	Define the interesting packets, which are packets that reset the idle timer or trigger calls. This dialer filter is defined by the **dialer-list 2** command. See Step 17[3].
11	`hq-sanjose(config-if)# ppp multilink`	Enable PPP multilink, which fragments and reassembles packets among bundled B channels.
12	`hq-sanjose(config-if)# ppp authentication chap pap`	Enable CHAP and PAP authentication. CHAP is used first. PAP is the second choice.
13	`hq-sanjose(config-if)# no fair-queue`	Disable fair queuing.
14	`hq-sanjose(config-if)# no cdp enable`	Disable the Cisco discovery protocol, unless you are using it for a specific purpose.
15	`hq-sanjose(config-if)# no ip mroute-cache`	Turn off multicast route caching.

Step	Command	Purpose
16	`hq-sanjose(config-if)# exit`	Return to global configuration mode.
17	`hq-sanjose(config)# dialer-list 2 protocol ip permit`	Define a DDR dialer-list to allow any IP traffic to maintain the connection. Any IP packet will maintain the DDR session. Minor or extensive tuning of your dialer list might be required to control costs in your environment.[3]

1. These users will also need a username and password.
2. Other environments might require shorter timeouts. The default is 120 seconds.
3. The **dialer-group** command and **dialer-list** command must use the same number. To monitor the idle timer value and the packets that reset it, use the **debug dialer packet** command and **show dialer** command.

Verify

To verify the configuration:

- Enter the **show dialer** command. This command shows you the state associated with each IP interface. Notice that each individual serial channel is actually a dialer interface.

```
hq-sanjose# show dialer

Dialer1 - dialer type = IN-BAND SYNC NO-PARITY
Idle timer (1800 secs), Fast idle timer (20 secs)
Wait for carrier (30 secs), Re-enable (15 secs)

Dial String      Successes   Failures    Last called   Last status

Serial0:0 - dialer type = ISDN
Idle timer (1800 secs), Fast idle timer (20 secs)
Wait for carrier (30 secs), Re-enable (15 secs)
Dialer state is idle

Serial0:1 - dialer type = ISDN
Idle timer (1800 secs), Fast idle timer (20 secs)
Wait for carrier (30 secs), Re-enable (15 secs)
Dialer state is idle

Serial0:2 - dialer type = ISDN
Idle timer (1800 secs), Fast idle timer (20 secs)
Wait for carrier (30 secs), Re-enable (15 secs)
Dialer state is idle

----- snip -----
```

- Enter the **show running** command:

```
hq-sanjose# show running
Building configuration...
Current configuration:
!
---- snip ----
!
interface Serial0:23
 no ip address
 no ip directed-broadcast
 dialer rotary-group 1
 isdn incoming-voice modem
!
interface Serial1:23
```

```
 no ip address
 no ip directed-broadcast
 dialer rotary-group 1
 isdn incoming-voice modem
!
interface Serial2:23
 no ip address
 no ip directed-broadcast
 dialer rotary-group 1
 isdn incoming-voice modem
!
interface Serial3:23
 no ip address
 no ip directed-broadcast
 dialer rotary-group 1
 isdn incoming-voice modem
!
---- snip ----
!
interface Dialer1
 ip address 10.1.254.1 255.255.255.0
 no ip directed-broadcast
 encapsulation ppp
 no ip mroute-cache
 dialer in-band
 dialer idle-timeout 1800
 dialer-group 2
 peer default ip address pool dialin_pool
 no fair-queue
 no cdp enable
 ppp authentication chap pap
 ppp multilink
!
dialer-list 2 protocol ip permit
!
---- snip ----
```

Step 12—Configuring Definitions for Remote LAN Sites

You must configure additional parameters to enable synchronous PPP services for the remote sites. Each remote site must have the following three entries configured on the Cisco AS5300:

- Username and password
- Static route
- Dialer map to support IP connectivity with the remote peer

Table 2-4 summarizes the critical parameters used by DDR, which works primarily at the addressing layer. These routes are stored in the routing table when the sites are not connected.

Table 2-4 Site Characteristics

Router Name	Password	WAN IP Address	Ethernet IP Address	Assigned Phone Number	Site Hardware
hq-sanjose	hq-sanjose-pw	10.1.254.1 255.255.255.0	10.1.1.10 255.255.255.0	4085551234	Cisco AS5300
soho-tahoe	tahoe-pw	10.1.254.3 255.255.255.0	10.1.3.1 255.255.255.0	5305558084	Cisco 766
robo-austin	austin-pw	10.1.254.4 255.255.255.0	10.1.4.1 255.255.255.0	5125554433	Cisco 1604

Configure

To enable the remote LANs to dial into the Cisco AS5300, use the following commands beginning in global configuration mode:

Step	Command	Purpose
1	`hq-sanjose(config)# username robo-austin password austin-pw`	Specify the robo-austin username and password[1].
2	`hq-sanjose(config)# ip route 10.1.4.0 255.255.255.0 10.1.254.4 permanent`	Enable IP routing for the robo-austin subnet.
3	`hq-sanjose(config)# username soho-tahoe password tahoe-pw`	Specify the soho-tahoe username and password[1].
4	`hq-sanjose(config)# ip route 10.1.3.0 255.255.255.0 10.1.254.3 permanent`	Enable IP routing for the soho-tahoe subnet.
5	`hq-sanjose(config)# interface dialer 1`	Enter interface dialer 1.
6	`hq-sanjose(config-if)# dialer map ip 10.1.254.4 name robo-austin #`	Create a dialer map entry to the robo-austin router[2].
7	`hq-sanjose(config-if)# dialer map ip 10.1.254.3 name soho-tahoe #`	Create a dialer map entry to the soho-tahoe router[2].

1. Make sure to use your own usernames and passwords for the remote sites.
2. In this case study, hq-sanjose does not dial out to the remote sites. The pound sign (#) is used to map the remote site's name to the IP address.

Verify

Enter the **show running** command:

```
hq-sanjose# show running
Building configuration...
Current configuration:
!
---- snip ----
!
username joe-admin password 7 <removed>
username robo-austin password 7 <removed>
username soho-tahoe password 7 <removed>
!
---- snip ----
!
interface Dialer1
 ip address 10.1.254.1 255.255.255.0
 no ip directed-broadcast
 encapsulation ppp
 no ip mroute-cache
 dialer in-band
 dialer idle-timeout 1800
 dialer map ip 10.1.254.3 name soho-tahoe #
 dialer map ip 10.1.254.4 name robo-austin #
 dialer-group 2
 peer default ip address pool dialin_pool
 no fair-queue
 no cdp enable
 ppp authentication chap pap
 ppp multilink
!
---- snip ----
!
ip local pool dialin_pool 10.1.2.2 10.1.2.97
ip route 10.1.3.0 255.255.255.0 10.1.254.3 permanent
ip route 10.1.4.0 255.255.255.0 10.1.254.4 permanent
!
dialer-list 2 protocol ip permit
!
---- snip ----
```

Tips

- Dialer mapping provides layer 3 to layer 2 address resolution for a telephone network. This is done by mapping a host name and IP address to a telephone number.
- To display the static and dynamic dialer maps, enter the **show dialer map** command on the Cisco AS5300.

Note If you want the Cisco AS5300 to initiate calls to the remote sites, you must define a dialer map phone number. This case study does not cover this option. See the *Dial Solutions Configuration Guide* for more information.

Step 13—Configuring a Backhaul Routing Protocol

Assign a routing protocol and configure its related configuration parameters to integrate with the IP backbone. The dialer network uses static routing.

Configure

To configure the routing protocol, use the following commands beginning in global configuration mode:

Step	Command	Purpose
1	hq-sanjose(config)# **router eigrp 10** hq-sanjose(config-router)# **network 10.0.0.0** hq-sanjose(config-router)# **passive-interface dialer 1** hq-sanjose(config-router)# **redistribute static** hq-sanjose(config-router)# **no auto-summary** hq-sanjose(config-router)# **exit**	Configure the Enhanced IGRP routing protocol, enable IP routing, turn off routing updates on the dialer interface, and advertise remote LAN static routes.
2	hq-sanjose(config)# **interface fastethernet 0** hq-sanjose(config-if)# **ip summary-address eigrp 10 10.1.2.0 255.255.255.0**	Configure a summary aggregate address on the Fast Ethernet interface 0. This step summarizes the IP addresses that are advertised to the backbone.

Verify

To verify the configuration:

- Enter the **show ip eigrp topology** command:

```
hq-sanjose# show ip eigrp topology
IP-EIGRP Topology Table for process 10
Codes: P - Passive, A - Active, U - Update, Q - Query, R - Reply,
       r - Reply status
P 10.1.3.0/24, 1 successors, FD is 46226176
         via Redistributed (46226176/0)
P 10.1.2.0/24, 1 successors, FD is 128256
         via Connected, Loopback0
P 10.1.4.0/24, 1 successors, FD is 46226176
         via Redistributed (46226176/0)
P 10.1.254.0/24, 1 successors, FD is 46226176
         via Connected, Dialer1
```

- Enter the **show running** command:

```
hq-sanjose# show running
Building configuration...

Current configuration:
!
---- snip ----
!
router eigrp 10
 redistribute static
 passive-interface Dialer1
 network 10.0.0.0
 no auto-summary
!
---- snip ----
```

Step 14—Confirming the Final Running Configuration

Here is the final running configuration:

```
hq-sanjose# show running
Building configuration...
Current configuration:
!
version 12.0
service timestamps debug datetime msec
service timestamps log datetime msec
service password-encryption
!
hostname hq-sanjose
!
aaa new-model
aaa authentication login default local
aaa authentication ppp default if-needed local
enable secret 5 $1$.voA$9/8.Zoil3jeWJMP6hEE6U0
!
username joe-admin password 7 <removed>
username robo-austin password 7 <removed>
username soho-tahoe password 7 <removed>
!
async-bootp dns-server 10.2.2.3 10.2.3.1
isdn switch-type primary-ni
!
!
controller T1 0
 framing esf
 clock source line primary
 linecode b8zs
 pri-group timeslots 1-24
!
controller T1 1
 framing esf
 clock source line secondary
 linecode b8zs
 pri-group timeslots 1-24
!
controller T1 2
 framing esf
 clock source internal
 linecode b8zs
 pri-group timeslots 1-24
!
controller T1 3
 framing esf
 clock source internal
 linecode b8zs
 pri-group timeslots 1-24
!
interface Loopback0
 ip address 10.1.2.1 255.255.255.0
 no ip directed-broadcast
!
interface Ethernet0
 no ip address
 no ip directed-broadcast
 no ip route-cache
 no ip mroute-cache
 shutdown
```

```
!
interface Serial0:23
 no ip address
 no ip directed-broadcast
 dialer rotary-group 1
 isdn incoming-voice modem
!
interface Serial1:23
 no ip address
 no ip directed-broadcast
 dialer rotary-group 1
 isdn incoming-voice modem
!
interface Serial2:23
 no ip address
 no ip directed-broadcast
 dialer rotary-group 1
 isdn incoming-voice modem
!
interface Serial3:23
 no ip address
 no ip directed-broadcast
 dialer rotary-group 1
 isdn incoming-voice modem
!
interface FastEthernet0
 ip address 10.1.1.10 255.255.255.0
 no ip directed-broadcast
 ip summary-address eigrp 10 10.1.2.0 255.255.255.0
 no ip route-cache
 no ip mroute-cache
 duplex auto
 speed auto
!
interface Group-Async1
 ip unnumbered Loopback0
 no ip directed-broadcast
 encapsulation ppp
 async mode interactive
 peer default ip address pool dialin_pool
 no cdp enable
 ppp authentication chap pap
 group-range 1 96
!
interface Dialer1
 ip address 10.1.254.1 255.255.255.0
 no ip directed-broadcast
 encapsulation ppp
 no ip mroute-cache
 dialer in-band
 dialer idle-timeout 1800
 dialer map ip 10.1.254.3 name soho-tahoe #
 dialer map ip 10.1.254.4 name robo-austin #
 dialer-group 2
 peer default ip address pool dialin_pool
 no fair-queue
 no cdp enable
 ppp authentication chap pap
 ppp multilink
!
router eigrp 10
 redistribute static
 passive-interface Dialer1
 network 10.0.0.0
 no auto-summary
```

```
!
ip local pool dialin_pool 10.1.2.2 10.1.2.97
ip route 10.1.3.0 255.255.255.0 10.1.254.3 permanent
ip route 10.1.4.0 255.255.255.0 10.1.254.4 permanent
!
dialer-list 2 protocol ip permit
!
!
line con 0
line 1 96
 autoselect during-login
 autoselect ppp
 modem InOut
line aux 0
line vty 0 4
!
end
```

Caution Do not expect your final configuration to look exactly like this one. You must localize for your own network environment. Additionally, most Cisco IOS software versions have different default settings. However, this final configuration provides a good basis for comparison.

Step 15—Saving the Configuration

Save the configuration to NVRAM by entering the **copy running-config startup-config** command.

Step 16—Testing Sync PPP Connections to Remote LANs

You must configure the remote ISDN routers before you can test DDR connections. For configuration tasks and end-to-end test examples, see the following chapters:

- Chapter 4, “Cisco 1604 Configuration”
- Chapter 5, “Cisco 766 Configuration”

Step 17—Adding More Remote LAN Sites as Needed

After you bring up your remote LANs and remote nodes, you might decide to expand the solution to a larger dial implementation. The following key items must be configured on the Cisco AS5300 to support each additional remote LAN router:

- One dialer map
- One IP route
- One username:password

Note The *italic* variables in Table 2-5 must be replaced with the actual WAN IP address, host name, IP subnet address, subnet mask, and password for each additional remote LAN router.

Table 2-5 Required Commands for Each Additional Site

Command	Purpose
dialer map ip *peer-wan-addr* **name** *hostname #*	A dialer map. Create a user entity in the security database for the remote site, which is appended to a dialer map[1].
ip route *subnet mask wan-addr*	A static route that points to the dialer map IP address.
username *hostname* **password** *password*	A username and password that matches the name on the dialer map.

1. If no phone number is used in the dialer map, this will prevent the central site from dialing out to the remote site.

Cisco 1604 Configuration

This chapter describes how to configure the Cisco 1604 to dial out to the Cisco AS5300.

Site Profile Characteristics

Figure 3-1 shows the network topology from the Cisco 1604's perspective.

Figure 3-1 Network Topology

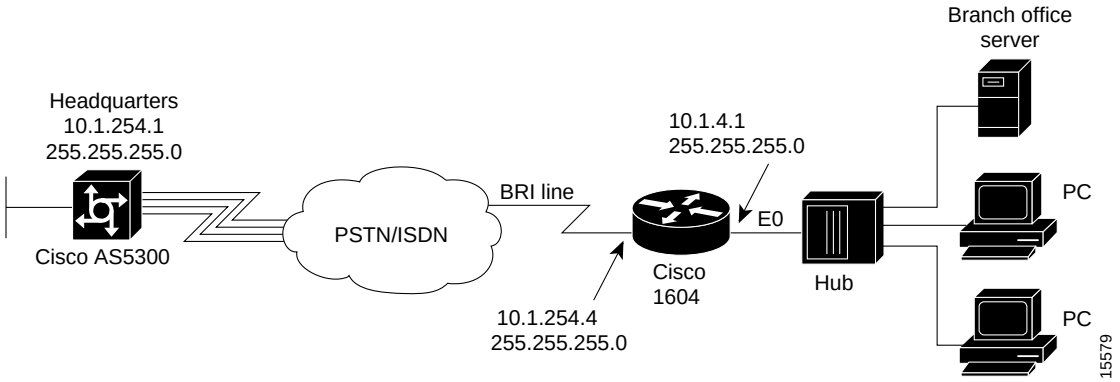


Table 3-1 provides detailed information about the end-to-end connection. This is the network administrator's top-level design table.

Table 3-1 Site Characteristics

Host Name/ Username	Username Password	WAN IP Address[1]	Ethernet IP Address	Assigned Phone Number	Site Hardware
robo-austin	austin-pw	10.1.254.4 255.255.255.0	10.1.4.1 255.255.255.0	Directory number = 5125554433	Cisco 1604
hq-sanjose	hq-sanjose-pw	10.1.254.1 255.255.255.0	10.1.1.10 255.255.255.0	4085551234	Cisco AS5300

1. The Cisco 1604's WAN default gateway is 10.1.254.1, which is the Cisco AS5300's dialer interface address.

Cisco IOS Release 12.0 is running inside the router. If the startup configuration is blank, the following screen is displayed at bootup. The automatic setup script is engaged. Enter **no** when you are asked the question, "Would you like to enter the initial configuration dialog? [yes]: **no**."

In this case study, the Cisco 1604 is manually configured. The automatic setup script is not used.

Note To enhance readability throughout this chapter, the most important output fields are highlighted with **bold** font. The commands you enter are also **bold** but are preceded by a router prompt.

```
System Bootstrap, Version 11.1(7)AX [kuong (7)AX], RELEASE SOFTWARE (fc1)
Copyright (c) 1994-1996 by cisco Systems, Inc.
C1600 processor with 2048 Kbytes of main memory

program load complete, entry point: 0x4018060, size: 0x1da928

Notice: NVRAM invalid, possibly due to write erase.

%QUICC_ETHER-1-LOSTCARR: Unit 0, lost carrier. Transceiver problem?program load
complete, entry point: 0x8000060, size: 0x3f5f2c

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Rights clause at FAR sec. 52.227-19 and subparagraph
(c) (1) (ii) of the Rights in Technical Data and Computer
Software clause at DFARS sec. 252.227-7013.

           cisco Systems, Inc.
           170 West Tasman Drive
           San Jose, California 95134-1706

Cisco Internetwork Operating System Software
IOS (tm) 1600 Software (C1600-SY-L), Version 12.0(x)
Copyright (c) 1986-1998 by cisco Systems, Inc.
Compiled Tue 25-Aug-98 01:45 by xxxx
Image text-base: 0x0802DA90, data-base: 0x02005000

ROM: System Bootstrap, Version 11.1(10)AA, EARLY DEPLOYMENT RELEASE SOFTWARE (fc1)

Router uptime is 10 minutes
System restarted by reload
System image file is "flash:c1600-sy-l.120-x"

cisco 1604 (68360) processor (revision C) with 17920K/512K bytes of memory.
Processor board ID 08823977, with hardware revision 00972006
Bridging software.
X.25 software, Version 3.0.0.
Basic Rate ISDN software, Version 1.1.
1 Ethernet/IEEE 802.3 interface(s)
1 ISDN Basic Rate interface(s)
System/IO memory with parity disabled
2048K bytes of DRAM onboard 16384K bytes of DRAM on SIMM
System running from FLASH
8K bytes of non-volatile configuration memory.
12288K bytes of processor board PCMCIA flash (Read ONLY)
```

```
         --- System Configuration Dialog ---

Would you like to enter the initial configuration dialog? [yes/no]: no

Would you like to terminate autoinstall? [yes]: yes


Press RETURN to get started!

00:00:17: %QUICC_ETHER-1-LOSTCARR: Unit 0, lost carrier. Transceiver problem?
00:00:17: %LINK-3-UPDOWN: Interface Ethernet0, changed state to up
00:00:17: %LINK-3-UPDOWN: Interface Serial0, changed state to down
00:00:17: %LINEPROTO-5-UPDOWN: Line protocol on Interface BRI0, changed state todown
00:00:17: %LINEPROTO-5-UPDOWN: Line protocol on Interface BRI0:1, changed state to down
00:00:17: %LINEPROTO-5-UPDOWN: Line protocol on Interface BRI0:2, changed state to down
00:00:17: %LINEPROTO-5-UPDOWN: Line protocol on Interface Ethernet0, changed state to
down
00:00:17: %LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0, changed stat to down
00:00:44: %LINK-5-CHANGED: Interface BRI0, changed state to administratively down
00:00:46: %LINK-5-CHANGED: Interface Serial0, changed state to administratively down
00:00:46: %LINK-5-CHANGED: Interface Ethernet0, changed state to administratively down
00:00:47: %IP-5-WEBINST_KILL: Terminating DNS process

Router>
```

Overview of Tasks

Perform the following steps to configure the router:

- "Step 1—Configuring the Host Name, Password, and Time Stamps" on page 4
- "Step 2—Configuring Local AAA Security" on page 5
- "Step 3—Configuring the Ethernet Interface" on page 7
- "Step 4—Configuring BRI" on page 9
- "Step 5—Configuring DDR" on page 11
- "Step 6—Testing Connections to the Cisco AS5300" on page 14
- "Step 7—Confirming the Final Running Configuration" on page 21
- "Step 8—Saving the Configuration" on page 21

Note Before you perform the configuration tasks in this chapter, be sure you understand the overall dial case action plan. See the chapter "Dial Case Study Overview."

Step 1—Configuring the Host Name, Password, and Time Stamps

Assign a host name to the Cisco 1604, enable basic security, and turn on time stamping. Configuring a host name allows you to distinguish between different network devices. Enable passwords allow you to prevent unauthorized configuration changes. Time stamps help you trace debug output for testing connections. Not knowing exactly when an event occurs hinders you from examining background processes.

Configure

To configure the host name, enable password, and time stamps, use the following commands beginning in user EXEC mode:

Step	Command	Purpose
1	`Router> enable`	Enter privileged EXEC mode.
2	`Router# configure terminal` `Enter configuration commands, one per line. End with CNTL/Z.`	Enter global configuration mode[1].
3	`Router(config)# hostname robo-austin`	Assign a host name to the router. This host name is typically used during authentication with the central site.
4	`robo-austin(config)# enable secret guessme`	Enter a secret enable password, which secures privileged EXEC mode[2].
5	`hq-sanjose(config)# service password-encryption`	Encrypt passwords in the configuration file for greater security[3].
6	`hq-sanjose(config)# service timestamps debug datetime msec` `hq-sanjose(config)# service timestamps log datetime msec`	Enable millisecond time stamping on debug and logging output. Time stamps are useful for detailed access tracing.

1. As you are configuring the software, make sure that all logging dialog generated by the router is displayed on your terminal screen. If it is not, enter the **terminal monitor** EXEC command. If you are configuring the router via the console port, logging is automatically displayed.
2. Make sure to change “guessme” to your own secret password.
3. Additional measures should be used, as the passwords are not strongly encrypted by today’s standards.

Verify

To verify the configuration:

- Enter the **show running** command:

```
robo-austin# show running
Building configuration...

Current configuration:
!
version 12.0
service timestamps debug uptime
service timestamps log uptime
service password-encryption
!
hostname robo-austin
!
enable secret 5 $1$og7B$nSwMZM0NBKTPhV09KVgxl1
!
interface Ethernet0
 no ip address
```

```
 shutdown
!
interface Serial0
 no ip address
 shutdown
!
interface BRI0
 no ip address
 shutdown
!
ip classless
!
!
line con 0
line vty 0 4
 login
!
```

- Try logging in with your new enable password. Exit out of enable mode using the **disable** command. The prompt changes from `robo-austin#` to `robo-austin>`. Enter the **enable** command followed by your password. The **show privilege** command shows the current security privilege level, which is level 15.

```
robo-austin# disable
robo-austin> enable
Password: letmein
robo-austin# show privilege
Current privilege level is 15
robo-austin#
```

Tips

If you have trouble:

- Make sure **Caps Lock** is off.
- Make sure you entered the correct password. Passwords are case sensitive.

Step 2—Configuring Local AAA Security

The Cisco IOS security model to use on all Cisco devices is authentication, authorization, and accounting (AAA). AAA provides the primary framework through which you set up access control on the access server.

- Authentication—Who are you?
- Authorization—What can you do?
- Accounting—What did you do?

In this case study, the same authentication method is used on all interfaces. AAA is set up to use the local database configured on the router. This local database is created with the **username** configuration commands.

Note After you finish setting up basic security, you can enhance the security solution by extending it to an external TACACS+ or RADIUS server. This case study describes local AAA security only.

Configure

To configure local AAA security, use the following commands beginning in global configuration mode:

Step	Command	Purpose
1	`robo-austin(config)# **username joe-admin password joe-password**`	Create a local username for yourself[1]. This step prevents you from getting locked out of the router when you enable AAA.
2	`robo-austin(config)# **aaa new-model**`	Enable AAA access control. This step immediately enables login and PPP authentication.
3	`robo-austin(config)# **aaa authentication login default local**`	Configure AAA to perform login authentication using the local username database. The **login** keyword indicates authentication of EXEC (shell) users.
4	`robo-austin(config)# **aaa authentication ppp default if-needed local**`	Configure PPP authentication to use the local database if the session was not already authenticated by **login**.

1. Make sure to change “joe-admin” to your own username and “joe-password” to your own password.

Verify

To verify the configuration:

- Try to log in with your username:pasword. Enter the **login** command at the EXEC (shell) prompt. Do not disconnect your EXEC session until you can log in successfully. (If you get locked out, you will need to perform password recovery by rebooting the router.)

```
robo-austin# login

User Access Verification

Username: joe-admin
Password: joe-password

robo-austin#
```

- Enter the **show running** command:

```
robo-austin# show running
Building configuration...

Current configuration:
!
version 12.0
service timestamps debug uptime
service timestamps log uptime
service password-encryption
!
hostname robo-austin
!
aaa new-model
aaa authentication login default local
aaa authentication ppp default if-needed local
enable secret 5 $1$og7B$nSwMZM0NBKTPhV09KVgxl1
```

```
!
username joe-admin password 7 <removed>
!
interface Ethernet0
 no ip address
 shutdown
!
interface Serial0
 no ip address
 shutdown
!
interface BRI0
 no ip address
 shutdown
!
ip classless
!
!
line con 0
line vty 0 4
!
```

Step 3—Configuring the Ethernet Interface

Assign an IP address to the Ethernet interface. Test the interface by pinging it from a PC on the LAN.

Configure

To configure the Ethernet interface, use the following commands beginning in global configuration mode:

Step	Command	Purpose
1	`robo-austin(config)# interface ethernet 0` `robo-austin(config-if)# ip address 10.1.4.1 255.255.255.0`	Configure the IP address and subnet mask on the Ethernet interface.
2	`robo-austin(config-if)# no shutdown`	Bring up the interface[1].

1. This command changes the state of the interface from administratively down to up.

Verify

To verify the configuration:

- Enter the **show ip interface brief** command, which allows you to quickly check the status of all router interfaces.

  The field "`administratively down`" means that the interface is configured with the **shutdown** command. To bring the interface up, you must enter the **no shutdown** command. The Status column refers to the ability to physically connect the network at layer 1 (needed for getting clocks and carrier signals). The Protocol column refers to the ability to see traffic flow, which typically occurs at the data link layer. For example, the Ethernet interface sends a loopback Ethernet packet out to itself via the Ethernet LAN.

```
robo-austin# show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
BRI0                   unassigned      YES unset  administratively down down
BRI0:1                 unassigned      YES unset  administratively down down
BRI0:2                 unassigned      YES unset  administratively down down
```

```
Ethernet0              10.1.4.1        YES manual up                    up
Serial0                unassigned      YES unset  administratively down down
```

In the next example, notice that the status is up but the protocol is down. The following logging message appears at 00:40:20: "`Unit 0, lost carrier. Transceiver problem?`."After the administrator plugs the Ethernet cable into the Ethernet port, the interface comes up. See 00:40:25.

```
robo-austin# show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
BRI0                   unassigned      YES unset  administratively down down
BRI0:1                 unassigned      YES unset  administratively down down
BRI0:2                 unassigned      YES unset  administratively down down
Ethernet0              10.1.4.1        YES manual up                    down
Serial0                unassigned      YES unset  administratively down down
robo-austin#
00:40:20: %QUICC_ETHER-1-LOSTCARR: Unit 0, lost carrier. Transceiver problem?
00:40:25: %LINEPROTO-5-UPDOWN: Line protocol on Interface Ethernet0, changed sta
te to up
robo-austin#
```

- Establish connectivity with an Ethernet-based device. In this example, IP address 10.1.4.2 is assigned to the first external PC on this LAN to test for router-to-PC connectivity. The PC's DOS prompt application is opened and the **ping 10.1.4.1** command is issued.

```
Microsoft(R) Windows 95
   (C)Copyright Microsoft Corp 1981-1996.

C:\WINDOWS> ping 10.1.4.1
Pinging 10.1.4.1 with 32 bytes of data:

Reply from 10.1.4.1: bytes=32 time=3ms TTL=236
Reply from 10.1.4.1: bytes=32 time=2ms TTL=236
Reply from 10.1.4.1: bytes=32 time=3ms TTL=236
Reply from 10.1.4.1: bytes=32 time=2ms TTL=236
```

- Try pinging the PC from the Cisco 1604. If the PC has not yet used any IP services or drivers, you might get a failure. The preferred method is to ping the router from a PC on the LAN first.

```
robo-austin# ping 10.1.4.2

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.4.2, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 4/5/8 ms
```

- If you know that the Ethernet interface is up but not performing correctly, enter the **show interface ethernet 0** command. This example shows errors in the counters, because the Ethernet cable was not plugged in.

```
robo-austin# show interface ethernet 0
Ethernet0 is up, line protocol is up
  Hardware is QUICC Ethernet, address is 0060.834f.6626 (bia 0060.834f.6626)
  Internet address is 10.1.4.1/24
  MTU 1500 bytes, BW 10000 Kbit, DLY 1000 usec, rely 234/255, load 1/255
  Encapsulation ARPA, loopback not set, keepalive set (10 sec)
  ARP type: ARPA, ARP Timeout 04:00:00
  Last input 00:00:08, output 00:00:04, output hang never
  Last clearing of "show interface" counters never
  Queueing strategy: fifo
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     2 packets input, 644 bytes, 0 no buffer
```

```
Received 2 broadcasts, 0 runts, 0 giants, 0 throttles
0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
0 input packets with dribble condition detected
28 packets output, 2905 bytes, 0 underruns
25 output errors, 0 collisions, 2 interface resets
0 babbles, 0 late collision, 0 deferred
3 lost carrier, 0 no carrier
0 output buffer failures, 0 output buffers swapped out
```

Step 4—Configuring BRI

Enable BRI connectivity with the central office switch. PPP framing is used on the B channels. Dial-on-demand routing (DDR) is configured in the next section "Step 5—Configuring DDR."

Note The **dialer in-band** command does not need to be configured on the BRI interface. A BRI interface is a dialer in-band interface by default. Interface BRI0:1 and BRI0:2 are controlled by the dialer interface "**interface bri 0**."

Configure

To configure BRI, use the following commands beginning in global configuration mode:

Step	Command	Purpose
1	`robo-austin(config)# isdn switch-type basic-ni1`	Configure the ISDN switch type, which is **basic-ni1** in this example.
2	`robo-austin(config)# interface bri 0` `robo-austin(config-if)# ip address 10.1.254.4 255.255.255.0`	Configure the IP address and subnet mask on the BRI interface.
3 8	`robo-austin(config-if)# isdn spid1 51255544330101` `robo-austin(config-if)# isdn spid2 51255544340101`	Configure your SPIDs, which are required by many switch types.
4	`robo-austin(config-if)# encapsulation ppp`	Enable PPP.
5	`robo-austin(config-if)# no fair-queue`	Disable fair queuing.
6	`robo-austin(config-if)# ppp multilink`	Enable PPP multilink.
7	`robo-austin(config-if)# ppp authentication chap pap callin`	Enable CHAP and PAP authentication on the interface during LCP negotiation. The access server will first authenticate with CHAP. If CHAP is not used by the remote client, then PAP is tried. CHAP is requested first.[1]
8	`robo-austin(config-if)# no shutdown`	Bring up the interface.[2]

1. You have the choice to authenticate the remote side on any connection. The **callin** keyword means that all outbound connection attempts made by the Cisco 1604 will not authenticate the remote peer. The remote peer is the device at the other end of the PPP link (Cisco AS5300). Only the calls that come into the Cisco 1604 will be authenticated.
2. The **no shutdown** command changes the state of the interface from administratively down to up.

Verify

- You should see the following output messages after you enter the **no shutdown** command.

  This example shows the BRI0:1 and BRI0:2 states change to "down," because the previous state was "administratively down." The BRI0 D channel changes to "up" as it spoofs for the two B channels. After the D channel finds the B channels, the B channels change state to "up." The Cisco 1604 communicates with the telephone switch and receives its TEI numbers for its two B channels.

```
robo-austin(config-if)# no shutdown
robo-austin#
00:45:01: %LINK-3-UPDOWN: Interface BRI0:1, changed state to down
00:45:01: %LINK-3-UPDOWN: Interface BRI0:2, changed state to down
00:45:01: %LINK-3-UPDOWN: Interface BRI0, changed state to up
robo-austin#
00:45:02: %ISDN-6-LAYER2UP: Layer 2 for Interface BR0, TEI 100 changed to up
00:45:02: %ISDN-6-LAYER2UP: Layer 2 for Interface BR0, TEI 101 changed to up
robo-austin(config-if)#
```

- Check the ISDN status by entering the **show isdn status** command:

```
robo-austin# show isdn status
Global ISDN Switchtype = basic-ni
ISDN BRI0 interface
        dsl 0, interface ISDN Switchtype = basic-ni
    Layer 1 Status:
        ACTIVE
    Layer 2 Status:
        TEI = 100, Ces = 1, SAPI = 0, State = MULTIPLE_FRAME_ESTABLISHED
        TEI = 101, Ces = 2, SAPI = 0, State = MULTIPLE_FRAME_ESTABLISHED
    Spid Status:
        TEI 100, ces = 1, state = 5(init)
            spid1 configured, no LDN, spid1 sent, spid1 valid
            Endpoint ID Info: epsf = 0, usid = 2, tid = 1
        TEI 101, ces = 2, state = 5(init)
            spid2 configured, no LDN, spid2 sent, spid2 valid
            Endpoint ID Info: epsf = 0, usid = 4, tid = 1
    Layer 3 Status:
        0 Active Layer 3 Call(s)
    Activated dsl 0 CCBs = 0
    Total Allocated ISDN CCBs = 0
```

Note Here are some defined terms from the output. DSL = Digital Subscriber Loop. CCBs = Call Control Blocks. TEI = Terminal Equipment Identifier. LDN = Local Directory Number. The BRI 0 interface corresponds to dsl 0, which has three channels (2B + D). The CCB counter increases by 1 for each active call on the Cisco 1604. The CCB counter for one call gets destroyed upon disconnect.

- Enter the **show ip interface brief** command to check the current state of the interface.

```
robo-austin# show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
BRI0                   10.1.254.4      YES manual up                    up
BRI0:1                 unassigned      YES unset  down                  down
BRI0:2                 unassigned      YES unset  down                  down
Ethernet0              10.1.4.1        YES manual up                    up
Serial0                unassigned      YES unset  administratively down down
```

Note Notice that the status and protocol for BRI 0 and Ethernet 0 are both up/up, which is what we expect to see. The term manual means that you manually configured the interface since the last reboot. The two B channels (BRI0:1 and BRI0:2) are down because there are no active calls on the BRI interface at this time.

Tips

If you have trouble:

- Make sure the correct ISDN switch type and SPIDs are configured.
- Make sure your BRI line is connected to the correct port.

Step 5—Configuring DDR

Set up the DDR routing components. In most cases, a remote site with a single LAN will require a simple DDR configuration. DDR is the mechanism that supports the routing table and call control in a circuit switched environment.

DDR in this case study takes the standard dialer map approach. You must configure specific parameters to establish connectivity with the Cisco AS5300 using sync PPP. Parameters include a static route, username:password, and a dialer map.

Configure

To configure DDR, use the following commands beginning in global configuration mode:

Step	Command	Purpose
1	`robo-austin(config)# interface bri 0`	Enter configuration mode for the BRI interface.
2	`robo-austin(config-if)# dialer-group 2`	Define the interesting packets that activate the ISDN connection. Interesting packets reset the idle timer and trigger dialing. This dialer filter is defined by the **dialer-list 2** command. See Step 7.
3	`robo-austin(config-if)# no fair-queue`	Disable fair queuing.
4	`robo-austin(config-if)# no cdp enable`	Disable the Cisco discovery protocol, unless you are using it for a specific purpose.
5	`robo-austin(config-if)# dialer load-threshold 60 either`	Configure the interface to bring up the second B channel when the bandwidth load exceeds 60/255.
6	`robo-austin(config-if)# dialer map ip 10.1.254.1 name hq-sanjose 14085551234` `robo-austin(config-if)# exit`	Build a dialer map that maps to the Cisco AS5300's IP address, host name, and directory number. The static route in Step 8 points to this dialer map.
7	`robo-austin(config)# dialer-list 2 protocol ip permit`	Define a DDR's dialer-list to allow any IP packets to establish and maintain calls.

Step	Command	Purpose
8	robo-austin(config) **ip route 0.0.0.0 0.0.0.0 10.1.254.1 permanent**	Create a static route for the next hop, which is the Cisco AS5300's WAN port. IP address 10.1.254.1 is used on the Cisco AS5300's dialer interface. This static route points at the dialer map on the access server's dialer interface.
9	robo-austin(config)# **username hq-sanjose password austin-pw**	When the Cisco AS5300 (hq-sanjose) authenticates the Cisco 1604 using CHAP, this password will be used by the Cisco 1604[1].
10	robo-austin(config)# **ip classless**	Ensure that all unknown subnets use the default route.

1. On Cisco IOS devices the PPP name is determined by one of the following commands: **hostname**, **sgbp group**, **ppp pap sent-username**, or **ppp chap hostname**.

Verify

To verify the configuration:

- Enter the **show ip route** command to confirm that the static route is installed and pointing at your dialer map address. The static IP default route must first be configured before you enter this command.

```
robo-austin# show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, * - candidate default
       U - per-user static route, o - ODR

Gateway of last resort is 10.1.254.1 to network 0.0.0.0

     10.0.0.0/24 is subnetted, 2 subnets
C       10.1.4.0 is directly connected, Ethernet0
C       10.1.254.0 is directly connected, BRI0
S*   0.0.0.0/0 [1/0] via 10.1.254.1
```

Note The static route is the first software building block (design crux) that receives the packet routed to the dialer map. The route must direct the packets to at the dialer map before the DDR features can establish connectivity.

- Enter the **show dialer** command. The following example shows that the Cisco 1604 has not placed any calls yet, and there have been no failures. An ISDN interface is a dialer interface. Key statistics are shown for each B channel.

```
robo-austin# show dialer

BRI0 - dialer type = ISDN

Dial String      Successes   Failures    Last called   Last status
14085551234            0          0            never          -
0 incoming call(s) have been screened.
```

```
0 incoming call(s) rejected for callback.

BRI0:1 - dialer type = ISDN
Idle timer (120 secs), Fast idle timer (20 secs)
Wait for carrier (30 secs), Re-enable (15 secs)
Dialer state is idle

BRI0:2 - dialer type = ISDN
Idle timer (120 secs), Fast idle timer (20 secs)
Wait for carrier (30 secs), Re-enable (15 secs)
Dialer state is idle
```

- Enter the **show dialer map** command to view the static dialer map that was built to the Cisco AS5300. This map is built using the phone number and WAN IP address of the access server.

```
robo-austin# show dialer map
Static dialer map ip 10.1.254.1 name hq-sanjose  (14085551234) on BRI0
```

- Enter the **show running** command:

```
robo-austin# show running
Building configuration...

Current configuration:
!
version 12.0
service timestamps debug uptime
service timestamps log uptime
service password-encryption
!
hostname robo-austin
!
aaa new-model
aaa authentication login default local
aaa authentication ppp default if-needed local
enable secret 5 $1$aZ1D$wNO71EpS6y5zRYuW9qFEr.
!
username joe-admin password 0 6y5zRYuW9qFEr$wNO71EpS6$aZ1
username hq-sanjose password 0 $wNO71EpS6y5zy5zRYuW9aZ1D$w
isdn switch-type basic-ni
!
interface Ethernet0
 ip address 10.1.4.1 255.255.255.0
!
interface Serial0
 no ip address
 shutdown
!
interface BRI0
 ip address 10.1.254.4 255.255.255.0
 encapsulation ppp
 dialer map ip 10.1.254.1 name hq-sanjose 14085551234
 dialer load-threshold 60 either
 dialer-group 2
 isdn switch-type basic-ni
 isdn spid1 51255544330101
 isdn spid2 51255544340101
 no cdp enable
 ppp authentication chap pap callin
 ppp multilink
 hold-queue 75 in
!
ip classless
ip route 0.0.0.0 0.0.0.0 10.1.254.1 permanent
```

```
!
dialer-list 2 protocol ip permit
!
line con 0
line vty 0 4
!
end
```

Tips

- To display the actual load currently assigned to the interface, enter the **show interface bri 0:1** command. Search for the output field "load x/255." SNMP can be used to monitor the load on an interface. How you set the threshold depends on each site's characteristics, such as traffic patterns and WAN costs. If you are in an environment where all calls are local, then you might nail up the connections full time.
- Large ISDN phone bills arise due to failure to appropriately tune filters and load thresholds. Filters are dialer lists, which are applied with dialer groups. The **dialer-list** command and **dialer-group** command control the first B channel. The **dialer load-threshold** command controls the behavior when additional B channels are connected.
- In this case study, the Cisco AS5300 does not dial out to the remote sites. Therefore, you do not need to tune the central site's dialer threshold setting. Only the remote side is in charge of opening and closing channels based on the settings of the dialer commands.
- Make sure you configured the correct SPID numbers on the BRI interface.

Step 6—Testing Connections to the Cisco AS5300

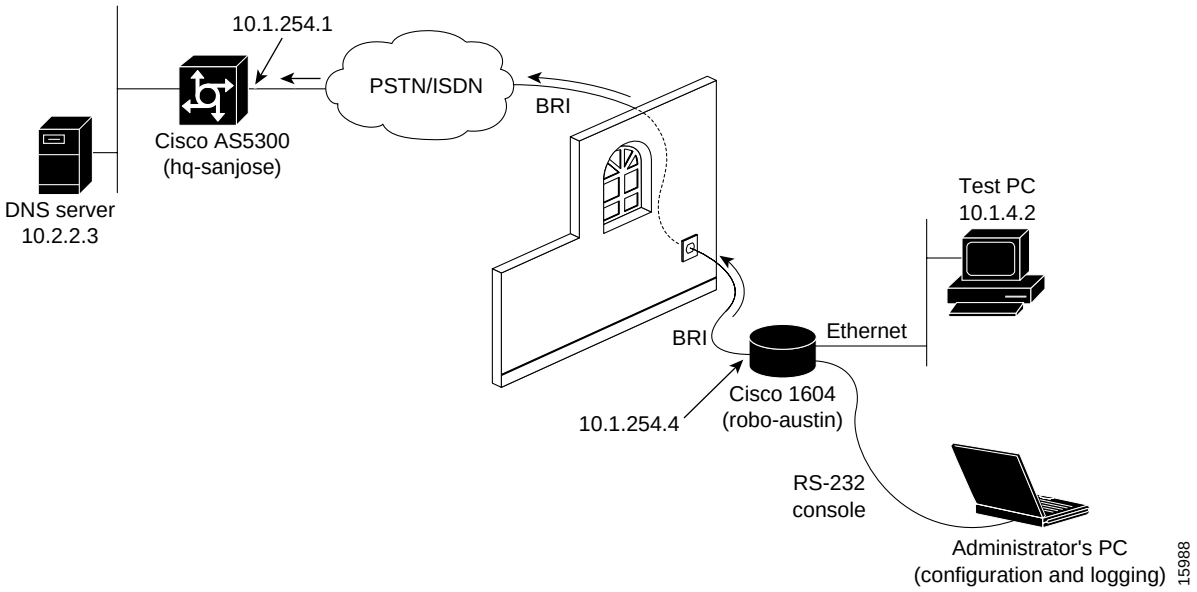
The test strategy is to ping the Cisco AS5300's WAN port then ping the backbone behind the access server. Cisco recommends you ping the domain name server (DNS) on the backbone, since this device should always be up and operational.

Pinging a next hop IP address can have complications in an IP-unnumbered environment. For example, complications arise when WAN interfaces are configured with IP unnumbered.

Note The typical low-level test to verify connectivity in a sync PPP environment is to ping a device on the other end of the WAN link. In a modem environment (async PPP), the low-level test is to get an EXEC shell established on the router.

Figure 3-2 shows the actual test lab environment used in this test case.

Figure 3-2 Test Lab Environment



Step 1 Turn on the appropriate debugging. Examining the background processes is essential for effective troubleshooting.

```
robo-austin# undebug all
All possible debugging has been turned off
robo-austin# terminal monitor
robo-austin# debug dialer
Dial on demand events debugging is on
robo-austin# debug isdn q931
ISDN Q931 packets debugging is on
robo-austin# debug ppp negotiation
PPP protocol negotiation debugging is on
robo-austin# debug ppp authentication
PPP authentication debugging is on
robo-austin# debug ip peer
IP peer address activity debugging is on
```

Step 2 Verify that your routing table points to the hq-sanjose network access server (NAS):

```
robo-austin# show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, * - candidate default
       U - per-user static route, o - ODR
Gateway of last resort is 10.1.254.1 to network 0.0.0.0
     10.0.0.0/24 is subnetted, 2 subnets
C       10.1.4.0 is directly connected, Ethernet0
C       10.1.254.0 is directly connected, BRI0
S*       0.0.0.0/0 [1/0] via 10.1.254.1
```

Step 3 Verify that the correct dialer map exists:

```
robo-austin# show dialer map
Static dialer map ip 10.1.254.1 name hq-sanjose  (14085551234) on BRI0
```

Step 4 Ping the IP address assigned to the Cisco AS5300's dialer interface. Notice that the Cisco 1604 (robo-austin) quickly gets 4 of 5 pings back from the Cisco AS5300 (hq-sanjose). After the ping is sent, examine the background processes as displayed by the debug output.

```
robo-austin# ping 10.1.254.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.254.1, timeout is 2 seconds:
.!!!!
Success rate is 80 percent (4/5), round-trip min/avg/max = 116/182/372ms
robo-austin#
```

Step 5 Look at the debug output. The following comments apply to the debug output example on the next page:

(a) See 08:03:55.
The source and destination IP address of the DDR dial cause are displayed.
(`s=10.1.254.4, d=10.1.254.1`)

(b) See 08:03:55.
Hq-sanjose's hunt group number is dialed.
(`Attempting to dial 14085551234`)

(c) See 08:03:55.
ISDN Setup is transmitted.
(`TX ->  SETUP pd = 8  callref = 0x2F`)

(d) See 08:03:55.
A synchronous data bearer capability is displayed.
(`Bearer Capability i = 0x8890`)

(e) See 08:03:55.
The outgoing LCP configuration request is made.
(`BR0:1 LCP: O CONFREQ [Closed] id 42 len 28`)

(f) See 08:03:55.
The incoming LCP configuration request wants to authenticate with CHAP.
(`AuthProto CHAP (0x0305C22305)`)

(g) See 08:03:55.
The outgoing acknowledgment says this peer will do CHAP.
(`LCP: O CONFACK [REQsent]`)

(h) See 08:03:55.
Both PPP peers have received LCP CONFACK. LCP is now open.
(`BR0:1 LCP: State is Open`)

(i) See 08:03:55.
Authentication phase is initiated by robo-austin.
(`BR0:1 PPP: Phase is AUTHENTICATING, by the peer`)

(j) See 08:03:55.
Robo-austin accepts a CHAP challenge initiated by hq-sanjose. The device robo-austin is not authenticating hq-sanjose, which is the desired behavior for this

scenario.
(BR0:1 CHAP: I CHALLENGE id 5 len 31 from "hq-sanjose")
(BR0:1 CHAP: O RESPONSE id 5 len 32 from "robo-austin")

(k) See 08:03:55.
The robo-austin PPP peer is successfully authenticated by the hq-sanjose peer.
(BR0:1 CHAP: I SUCCESS id 5 len 4)

(l) See 08:03:55.
MultiLink PPP uses a virtual-access interface to host the bundle.
(BR0:1 PPP: Phase is VIRTUALIZED)

(m) See 08:03:56.
LCP on Virtual-Access2 is forced up as it was already negotiated on the physical interface. For more information, use the **show interface virtual-access2 conf** command and **debug vtemp** command.
(%LINK-3-UPDOWN: Interface Virtual-Access2, changed state to up)
(Vi2 PPP: Phase is UP)

(n) See 08:03:56.
IPCP negotiation begins.
(Vi2 IPCP: O CONFREQ [Closed] id 1 len 10)
(Vi2 IPCP: Address 10.1.254.4 (0x03060A01FE04))

(o) See 08:03:56.
IP can now be used across this PPP connection.
(Vi2 IPCP: I CONFACK [ACKsent] id 1 len 10)
(Vi2 IPCP: State is Open)

(p) See 08:03:57.
A route is installed to 10.1.254.1 to match the IP address negotiated by the peer.
(BR0 IPCP: Install route to 10.1.254.1)

(q) See 08:03:57 and 08:04:01.
The connection is made to hq-sanjose.
(Line protocol on Interface Virtual-Access2, changed state to up)
(Interface BRI0:1 is now connected to 14085551234 hq-sanjose)

```
robo-austin# ping 10.1.254.1
Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 10.1.254.1, timeout is 2 seconds:
.!!!!
Success rate is 80 percent (4/5), round-trip min/avg/max = 116/182/372ms
robo-austin#

08:03:55: BRI0: Dialing cause ip (s=10.1.254.4, d=10.1.254.1)
08:03:55: BRI0: Attempting to dial 14085551234
08:03:55: ISDN BR0: TX ->  SETUP pd = 8  callref = 0x2F
08:03:55:         Bearer Capability i = 0x8890
08:03:55:         Channel ID i = 0x83
08:03:55:         Keypad Facility i = '14085551234'
08:03:55: ISDN BR0: RX <-  CALL_PROC pd = 8  callref = 0xAF
08:03:55:         Channel ID i = 0x89
08:03:55: ISDN BR0: RX <-  CONNECT pd = 8  callref = 0xAF
08:03:55: ISDN BR0: TX ->  CONNECT_ACK pd = 8  callref = 0x2F
08:03:55: %LINK-3-UPDOWN: Interface BRI0:1, changed state to up
08:03:55: BR0:1 PPP: Treating connection as a callout
08:03:55: BR0:1 PPP: Phase is ESTABLISHING, Active Open
08:03:55: BR0:1 PPP: No remote authentication for call-out
08:03:55: BR0:1 LCP: O CONFREQ [Closed] id 42 len 28
08:03:55: BR0:1 LCP:    MagicNumber 0x623E5C69 (0x0506623E5C69)
08:03:55: BR0:1 LCP:    MRRU 1524 (0x110405F4)
```

```
08:03:55: BR0:1 LCP:    EndpointDisc 1 Local
(0x130E01726F626F2D61757374696E)
08:03:55: BR0:1 LCP: I CONFREQ [REQsent] id 7 len 32
08:03:55: BR0:1 LCP:    AuthProto CHAP (0x0305C22305)
08:03:55: BR0:1 LCP:    MagicNumber 0xE16A73E6 (0x0506E16A73E6)
08:03:55: BR0:1 LCP:    MRRU 1524 (0x110405F4)
08:03:55: BR0:1 LCP:    EndpointDisc 1 Local
(0x130D0168712D73616E6A6F7365)
08:03:55: BR0:1 LCP: O CONFACK [REQsent] id 7 len 32
08:03:55: BR0:1 LCP:    AuthProto CHAP (0x0305C22305)
08:03:55: BR0:1 LCP:    MagicNumber 0xE16A73E6 (0x0506E16A73E6)
08:03:55: BR0:1 LCP:    MRRU 1524 (0x110405F4)
08:03:55: BR0:1 LCP:    EndpointDisc 1 Local
(0x130D0168712D73616E6A6F7365)
08:03:55: BR0:1 LCP: I CONFACK [ACKsent] id 42 len 28
08:03:55: BR0:1 LCP:    MagicNumber 0x623E5C69 (0x0506623E5C69)
08:03:55: BR0:1 LCP:    MRRU 1524 (0x110405F4)
08:03:55: BR0:1 LCP:    EndpointDisc 1 Local
(0x130E01726F626F2D61757374696E).
08:03:55: BR0:1 LCP: State is Open
08:03:55: BR0:1 PPP: Phase is AUTHENTICATING, by the peer
08:03:55: BR0:1 CHAP: I CHALLENGE id 5 len 31 from "hq-sanjose"
08:03:55: BR0:1 CHAP: O RESPONSE id 5 len 32 from "robo-austin"
08:03:55: BR0:1 CHAP: I SUCCESS id 5 len 4
08:03:55: BR0:1 PPP: Phase is VIRTUALIZED
08:03:55: BR0:1 IPCP: Packet buffered while building MLP bundle
interface
08:03:56: Vi2 PPP: Phase is DOWN, Setup
08:03:56: %LINEPROTO-5-UPDOWN: Line protocol on Interface BRI0:1,
changed state to up
08:03:56: %LINK-3-UPDOWN: Interface Virtual-Access2, changed state to up
08:03:56: Vi2 PPP: Treating connection as a callout
08:03:56: Vi2 PPP: Phase is ESTABLISHING, Active Open
08:03:56: Vi2 PPP: No remote authentication for call-out
08:03:56: Vi2 LCP: O CONFREQ [Closed] id 1 len 28
08:03:56: Vi2 LCP:    MagicNumber 0x623E60D6 (0x0506623E60D6)
08:03:56: Vi2 LCP:    MRRU 1524 (0x110405F4)
08:03:56: Vi2 LCP:    EndpointDisc 1 Local
(0x130E01726F626F2D61757374696E)
08:03:56: Vi2 PPP: Phase is UP
08:03:56: Vi2 IPCP: O CONFREQ [Closed] id 1 len 10
08:03:56: Vi2 IPCP:    Address 10.1.254.4 (0x03060A01FE04)
08:03:56: Vi2 PPP: Pending ncpQ size is 1
08:03:56: BR0:1 IPCP: Redirect packet to Vi2
08:03:56: Vi2 IPCP: I CONFREQ [REQsent] id 1 len 10
08:03:56: Vi2 IPCP:    Address 10.1.254.1 (0x03060A01FE01)
08:03:56: set_ip_peer_addr: Vi2: address = 10.1.254.1 (7)
08:03:56: Vi2 IPCP: O CONFACK [REQsent] id 1 len 10
08:03:56: Vi2 IPCP:    Address 10.1.254.1 (0x03060A01FE01)
08:03:57: Vi2 IPCP: I CONFACK [ACKsent] id 1 len 10
08:03:57: Vi2 IPCP:    Address 10.1.254.4 (0x03060A01FE04)
08:03:57: Vi2 IPCP: State is Open
08:03:57: dialer Protocol up for Vi2
08:03:57: BR0 IPCP: Install route to 10.1.254.1
08:03:57: %LINEPROTO-5-UPDOWN: Line protocol on Interface
Virtual-Access2, changed state to up
08:04:01: %ISDN-6-CONNECT: Interface BRI0:1 is now connected to
14085551234 hq-sanjose
```

Step 6 Ping the DNS server behind hq-sanjose. The DNS server is the first backbone device that Cisco 1604 will try to use. The DNS server in this case study uses 10.2.2.3.

```
robo-austin# ping 10.2.2.3

Type escape sequence to abort.
```

```
Sending 5, 100-byte ICMP Echos to 10.2.2.3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 4/7/12 ms
```

Step 7 Use additional commands to verify robo-austin's connection with hq-sanjose:

```
robo-austin# show dialer map
Static dialer map ip 10.1.254.1 name hq-sanjose  (14085551234) on BRI0

robo-austin# show dialer

BRI0 - dialer type = ISDN

Dial String      Successes   Failures    Last called   Last status
14085551234          1           0         00:00:30     successful
0 incoming call(s) have been screened.
0 incoming call(s) rejected for callback.

BRI0:1 - dialer type = ISDN
Idle timer (120 secs), Fast idle timer (20 secs)
Wait for carrier (30 secs), Re-enable (15 secs)
Dialer state is multilink member
Dial reason: ip (s=10.1.254.4, d=10.1.254.1)
Connected to 14085551234 (hq-sanjose)

BRI0:2 - dialer type = ISDN
Idle timer (120 secs), Fast idle timer (20 secs)
Wait for carrier (30 secs), Re-enable (15 secs)
Dialer state is idle

Virtual-Access1 - dialer type = IN-BAND SYNC NO-PARITY
Rotary group 0, priority 0
Idle timer (120 secs), Fast idle timer (20 secs)
Wait for carrier (30 secs), Re-enable (15 secs)
Dialer state is data link layer up
Time until disconnect 105 secs
Connected to 14085551234 (hq-sanjose)

robo-austin# show ppp multilink

Bundle hq-sanjose, 1 member, Master link is Virtual-Access1
Dialer Interface is BRI0
  0 lost fragments, 0 reordered, 0 unassigned, sequence 0x0/0x0 rcvd/sent
  0 discarded, 0 lost received, 1/255 load

Member Link: 1 (max not set, min not set)
BRI0:1

robo-austin# show interface bri 0:1
BRI0:1 is up, line protocol is up
  Hardware is BRI
  MTU 1500 bytes, BW 64 Kbit, DLY 20000 usec, rely 255/255, load 1/255
  Encapsulation PPP, loopback not set, keepalive set (10 sec)
  LCP Open, multilink Open
  Last input 00:00:07, output 00:00:07, output hang never
  Last clearing of "show interface" counters never
  Queueing strategy: fifo
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     472 packets input, 13496 bytes, 0 no buffer
     Received 469 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     504 packets output, 18013 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
```

```
     0 output buffer failures, 0 output buffers swapped out
     104 carrier transitions

robo-austin# show ip interface brief
Interface              IP-Address      OK? Method Status                Protocol
BRI0                   10.1.254.4      YES manual up                    up
BRI0:1                 unassigned      YES unset  up                    up
BRI0:2                 unassigned      YES unset  down                  down
Ethernet0              10.1.3.1        YES manual up                    up
Serial0                unassigned      YES unset  administratively down down
Virtual-Access1        unassigned      YES unset  up                    up

robo-austin# show interface bri 0 1 2
BRI0:1 is up, line protocol is up
  Hardware is BRI
  MTU 1500 bytes, BW 64 Kbit, DLY 20000 usec, rely 255/255, load 1/255
  Encapsulation PPP, loopback not set, keepalive set (10 sec)
  LCP Open, multilink Open
  Last input 00:00:00, output 00:00:00, output hang never
  Last clearing of "show interface" counters never
  Queueing strategy: fifo
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     478 packets input, 13592 bytes, 0 no buffer
     Received 474 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     509 packets output, 18093 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out
     104 carrier transitions
BRI0:2 is down, line protocol is down
  Hardware is BRI
  MTU 1500 bytes, BW 64 Kbit, DLY 20000 usec, rely 255/255, load 1/255
  Encapsulation PPP, loopback not set, keepalive set (10 sec)
  LCP Closed, multilink Closed
  Closed: IPCP
  Last input 00:09:36, output 00:09:36, output hang never
  Last clearing of "show interface" counters never
  Queueing strategy: fifo
  Output queue 0/40, 0 drops; input queue 0/75, 0 drops
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     23 packets input, 722 bytes, 0 no buffer
     Received 23 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored, 0 abort
     22 packets output, 727 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 output buffer failures, 0 output buffers swapped out
     2 carrier transitions

robo-austin# show user
    Line     User      Host(s)                 Idle Location
*  0 con 0   admin     idle                    0
  BR0:1      hq-sanjoe Sync PPP                00:00:38
```

Step 7—Confirming the Final Running Configuration

Here is the final running configuration for the Cisco 1604:

```
robo-austin# show running
Building configuration...
Current configuration:
!
version 12.0
service timestamps debug uptime
service timestamps log uptime
service password-encryption
!
hostname robo-austin
!
aaa new-model
aaa authentication login default local
aaa authentication ppp default if-needed local
enable secret 5 $1$aZ1D$wNO71EpS6y5zRYuW9qFEr.
!
username joe-admin password 7 <removed>
username hq-sanjose password 7 <removed>
isdn switch-type basic-ni!
!
interface Ethernet0
 ip address 10.1.4.1 255.255.255.0
!
interface BRI0
 ip address 10.1.254.4 255.255.255.0
 encapsulation ppp
 no ip route-cache
 dialer map ip 10.1.254.1 name hq-sanjose 14085551234
 dialer load-threshold 60 either
 dialer-group 2
 isdn switch-type basic-ni
 isdn spid1 51255544330101
 isdn spid2 51255544340101
 no cdp enable
 ppp authentication chap callin
 ppp multilink
 hold-queue 75 in
!
ip classless
ip route 0.0.0.0 255.0.0.0 10.1.254.1 permanent
!
!
dialer-list 2 protocol ip permit
!
line con 0
line vty 0 4
!
end
```

Step 8—Saving the Configuration

Save the configuration to NVRAM by entering the **copy running-config startup-config** command.

Cisco 766 Configuration

This chapter describes how to configure the Cisco 766 to dial out to the Cisco AS5300.

Site Profile Characteristics

Figure 4-1 shows the network topology from the Cisco 766's perspective.

Figure 4-1 Network Topology

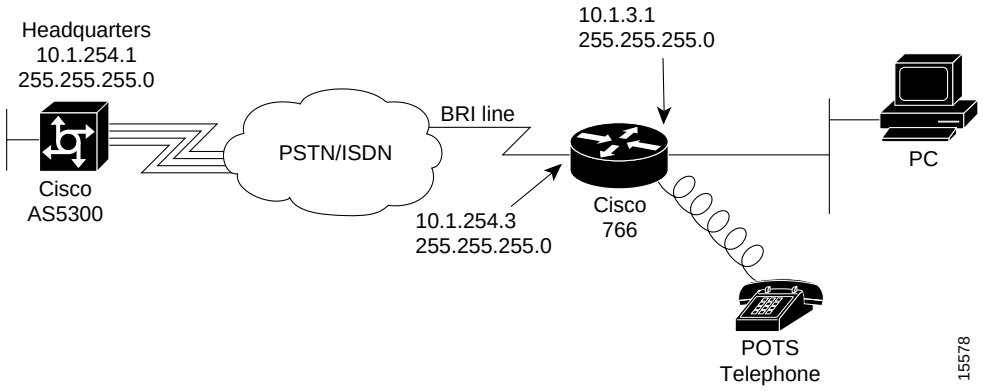


Table 4-1 provides detailed information about each end of the connection. This is the network administrator's top-level design table.

Table 4-1 Site Characteristics

Host Name/ Username	Username Password	WAN IP Address[1]	Ethernet IP Address	Assigned Phone Number	Site Hardware
soho-tahoe	tahoe-pw	10.1.254.3 255.255.255.0	10.1.3.1 255.255.255.0	Directory numbers = 5558084 5558085	Cisco 766
hq-sanjose	hq-sanjose-pw	10.1.254.1 255.255.255.0	10.1.1.10 255.255.255.0	4085551234	Cisco AS5300

1. The Cisco 766's default route is 10.1.254.1, which is the Cisco AS5300's dialer interface IP address. This is the next hop IP address.

Note To enhance readability throughout this chapter, the most important output fields are highlighted with **bold** font. The commands you enter are also **bold** but are preceded by a router prompt.

Overview of Tasks

Perform the following steps:

- "Step 1—Configuring System Level Settings" on page 2
- "Step 2—Configuring the LAN Profile" on page 5
- "Step 3—Configuring the Site Profile hq-sanjose" on page 7
- "Step 4—Testing Connections to the Cisco AS5300" on page 9
- "Step 5—Confirming the Final Running Configuration" on page 11

Note Before you perform the configuration tasks in this chapter, be sure you understand the overall software configuration action plan. See the chapter "Dial Case Study Overview."

Step 1—Configuring System Level Settings

System level settings include system name, security, ISDN setup, and PPP setup.

Configure

To configure the system level settings, use the following commands in system mode:

Step	Command	Purpose
1	`> set system soho-tahoe`	Enter the host name for this Cisco 766.
2	`soho-tahoe> set switch ni1`	Specify the ISDN switch type that your phone company uses.
3	`soho-tahoe> set 1 directorynumber 5558084` `soho-tahoe> set 2 directorynumber 5558085`	Enter the directory numbers for the BRI port's two B channels.
4	`soho-tahoe> set 1 spid 53055580840101` `soho-tahoe> set 2 spid 53055580850101`	Configure your SPIDs, which are required by many switches types. The SPID number is a derivative of the directory number.
5	`soho-tahoe> set phone1 5558084` `soho-tahoe> set phone2 5558085`	Enable calls to route to the phone 1 and phone 2 POTS jacks.
6	`soho-tahoe> set voicepriority out conditional` `soho-tahoe> set voicepriority in conditional`	Set the incoming and outgoing voice priority mode. It determines whether the system will disconnect a B channel assigned to a data call to allow a voice call.
7	`soho-tahoe> set ppp multilink on`	Turn on multilink PPP.
8	`soho-tahoe> set ppp authentication incoming chap`	Authenticate incoming callers using CHAP.

9	`soho-tahoe> set ppp secret host`
	`Enter new password: tahoe-pw`
	`Re-Type new password: tahoe-pw`
		Specify the CHAP password for authenticating PPP peers. You must enter it twice for verification[1].

Step	Command	Purpose
10	soho-tahoe> **set password system** Enter new password: **admin-pw** Re-Type new password: **admin-pw**	Protect your Cisco 766 terminal service shell with a password[1]. The system configuration mode can be accessed through the console port or a telnet session[2].

1. Make sure to use your own secret password. Do not use “tahoe-pw” or “admin-pw.”
2. To modify what is protected by the password, use the **set local access** command.

Verify

To verify the configuration:

- Enter the **show configuration** command to display a subset of the current configuration parameters:

Note This case study configures IP routing on the LAN and access profile. The internal profile is not used. See the display field “`Profile Parameters`.”

```
soho-tahoe> show configuration
System Parameters
    Environment
      Screen Length          20
      Echo Mode              ON
      CountryGroup           1
    Bridging Parameters
      LAN Forward Mode       ANY
      WAN Forward Mode       ONLY
      Address Age Time       OFF
    Call Startup Parameters
      Multidestination       OFF
    Line Parameters
      Switch Type            NI-1
      Svc Profile ID 1       53055580840101
      Directory Number(s)    5558084
      Svc Profile ID 2       53055580850101
      Directory Number(s)    5558085
      Auto SPID and Switch Detection   OFF
      Conference access code 60
Transfer access code   61
    Call Parameters          Link 1            Link 2
      Retry Delay              30                30
      Button                 Standard

Profile Parameters
    Bridging Parameters
      Bridging               ON
      Routed Protocols       NONE
      Learn Mode             ON
      Passthru               OFF
    Call Startup Parameters
    Line Parameters
      Line Speed             AUTO
      Numbering Plan         NORMAL
    Call Parameters          Link 1            Link 2
      Auto                     ON                ON
      Called Number
      Backup Number
      Ringback Number
```

```
      CLI Validate Number
    CLICallback             OFF
    CLIAuthentication       OFF
```

- Enter the **show security** command to display the current system security configuration:

```
soho-tahoe> show security
System Parameters
    Security
      Access Status           ON
      System Password         EXISTS
      Remote Configuration    PROTECTED
      Local Configuration     ON
      ClickStart              ON
      Logout Timeout          5
      Caller ID Security      OFF
      Caller Id Numbers

    PPP Security
      PPP Authentication  IN  CHAP
      CHAP REFUSE             NONE

Profile Parameters
    PPP Security
      PPP Authentication OUT  NONE
      PPP Authentication ACCEPT  EITHER
      Token Authentication Support
        TAS Client            0.0.0.0
        Use Local CHAP Secret ON
      Client
        User Name             soho-tahoe
        PAP Password          NONE
        CHAP Secret           NONE
      Host
        PAP Password          NONE
        CHAP Secret           EXISTS
      Callback
        Request               OFF
        Reply                 OFF
```

- Enter the **show status** command:

```
soho-tahoe> show status
Status    01/01/1998 00:01:08
Line Status
  Line Activated
  Terminal Identifier Assigned    SPID Accepted
  Terminal Identifier Assigned    SPID Accepted
Port Status                                        Interface
Connection Link
  Ch:  1      Waiting for Call
  Ch:  2      Waiting for Call
```

Step 2—Configuring the LAN Profile

The LAN profile contains the Cisco 766's Ethernet IP address and routing characteristics. Before you configure the LAN profile, you should understand how profiles work.

The Cisco 766's operating system uses a profile model. The LAN and remote site parameters are configured inside profiles. When using the command line interface for configuring the device, the current mode determines the effect and display output of each command. The current mode is indicated by the router prompt. To move between modes, use the **cd** command.

```
soho-tahoe>       <---------------------- This is system mode.
soho-tahoe> cd lan    <------------------- Change to the LAN profile.
soho-tahoe:LAN> cd hq-sanjose     <------- Change to the hq-sanjose profile.
soho-tahoe:hq-sanjose> cd    <------------ Go back to system mode.
soho-tahoe>
```

Note For illustrative purposes, the hq-sanjose profile is included in this example. The actual hq-sanjose profile is configured later in the next section "Step 3—Configuring the Site Profile hq-sanjose."

In the following example, notice that the output of the **show security** command is different for each configuration mode.

```
soho-tahoe> show security
System Parameters
    Security
      Access Status            ON
      System Password          EXISTS
      Remote Configuration     PROTECTED
      Local Configuration      ON
      ClickStart               ON
      Logout Timeout           5
      Caller ID Security       OFF
      Caller Id Numbers

    PPP Security
      PPP Authentication  IN   CHAP
      CHAP REFUSE              NONE

Profile Parameters
    PPP Security
      PPP Authentication OUT   NONE
      PPP Authentication ACCEPT   EITHER
      Token Authentication Support
        TAS Client             0.0.0.0
        Use Local CHAP Secret  ON
      Client
        User Name              soho-tahoe
        PAP Password           NONE
        CHAP Secret            NONE
      Host
        PAP Password           NONE
        CHAP Secret            EXISTS
      Callback
        Request                OFF
        Reply                  OFF
```

```
soho-tahoe> cd hq-sanjose
soho-tahoe:hq-sanjose> show security

Profile Parameters
    PPP Security
      PPP Authentication OUT      NONE<*>
      PPP Authentication ACCEPT   EITHER
      Token Authentication Support
        TAS Mode                  OFF
        TAS Client                0.0.0.0
        Use Local CHAP Secret     ON
      Client
        User Name                 soho-tahoe
        PAP Password              NONE
        CHAP Secret               EXISTS
      Host
        PAP Password              NONE
        CHAP Secret               EXISTS
      Callback
        Request                   OFF
        Reply                     OFF
```

Configure

To configure the LAN profile parameters, use the following commands beginning in system configuration mode:

Step	Command	Purpose
1	`soho-tahoe> cd lan`	Enter LAN profile mode.
2	`soho-tahoe:LAN> set ip address 10.1.3.1`	Enter the IP address.
3	`soho-tahoe:LAN> set netmask 255.255.255.0`	Configure the subnet mask.
4	`soho-tahoe:LAN> set bridging off`	Turn bridging off.
5	`soho-tahoe:LAN> set ip routing on`	Turn on IP routing.
6	`soho-tahoe:LAN> set ip rip update off`	Turn off IP RIP updates.

Verify

To verify the configuration:

- Enter the **show configuration** command to display the current LAN configuration:

```
soho-tahoe:LAN> show configuration

Profile Parameters
    Bridging Parameters
      Bridging                OFF<*>
      Routed Protocols        IP <*>
      Learn Mode              ON
      Passthru                OFF
    Call Startup Parameters
    Line Parameters
      Line Speed              AUTO
      Numbering Plan          NORMAL
    Call Parameters           Link 1            Link 2
      Auto                      ON                ON
      Called Number
      Backup Number
```

```
  Ringback Number
  CLI Validate Number
CLICallback             OFF
CLIAuthentication       OFF
```

- Enter the **show lan packets** command to display packeting statistics associated with the LAN interface:

```
soho-tahoe:LAN> show lan packets
Packet Statistics for LAN
Filtered: 120  Forwarded: 1  Received: 124
Dropped: 0  Lost: 0   Corrupted: 0  Misordered: 0
Ethernet Type:  0800  Count:  15
Ethernet Type:  0806  Count:  7
```

Step 3—Configuring the Site Profile hq-sanjose

The hq-sanjose profile provides the dialing characteristics for connecting to the Cisco AS5300 (hq-sanjose).

Configure

To configure the site profile, use the following commands beginning in LAN profile mode:

Step	Command	Purpose
1	`soho-tahoe:LAN> set user hq-sanjose` `soho-tahoe> New user hq-sanjose being created`	Create the profile for the headquarters NAS. This profile name must match the PPP name sent by the NAS during CHAP authentication[1].
2	`soho-tahoe:hq-sanjose> set prof power=activate user=hq-sanjose` `soho-tahoe:hq-sanjose> set active`	Ensure that the profile is currently active and active at reboot.
3	`soho-tahoe:hq-sanjose> set encap ppp`	Enable PPP encapsulation.
4	`soho-tahoe:hq-sanjose> set ip routing on`	Turn on IP routing.
5	`soho-tahoe:hq-sanjose> set ip framing none`	Set IP framing for PPP encapsulation.
6	`soho-tahoe:hq-sanjose> set ip address 10.1.254.3`	Set the IP address to be used on the WAN port when using this profile. See Table 4-1.
7	`soho-tahoe:hq-sanjose> set ip netmask 255.255.255.0`	Set the IP netmask address for the dialer cloud.
8	`soho-tahoe:hq-sanjose> set ip route destination 0.0.0.0 gateway 10.1.254.1`	Create a static route for the next hop, which is the Cisco AS5300's WAN port. IP address 10.1.254.1 is used on the Cisco AS5300's dialer interface[2].
9	`soho-tahoe:hq-sanjose> set bridging off`	Turn off bridging.
10	`soho-tahoe:hq-sanjose> set ip rip update off`	Turn off IP RIP updates.
11	`soho-tahoe:hq-sanjose> set number 14085551234`	Enter the hq-sanjose telephone number.
12	`soho-tahoe:hq-sanjose> set speed 56k`	Start your connection testing with 56K, which is often a more dependable connect speed[3].
13	`soho-tahoe:hq-sanjose> set ppp authentication outgoing none`	When soho-tahoe dials out, it will not authenticate hq-sanjose.
14	`soho-tahoe:hq-sanjose> set ppp authentication incoming chap`	All incoming PPP callers are authenticated with CHAP.

Step	Command	Purpose
15	soho-tahoe:hq-sanjose> **set ppp secret client** soho-tahoe:hq-sanjose> Enter new Password: **tahoe-pw** soho-tahoe:hq-sanjose> Re-Type new Password: **tahoe-pw**	Specify the secret password to use when soho-tahoe is logging into hq-sanjose[4].

1. On Cisco IOS devices the PPP name is defined by one of the following commands: **hostname**, **sgbp group**, **ppp pap sent-username**, or **ppp chap hostname**.
2. By definition IP address 10.1.254.1 is connected to the Cisco 766's BRI interface, because the dialer's subnet contains address 10.1.254.1.
3. You are less likely to run into a problem by using 56K. After the connection is up and operational, try to upgrade the speed to 64K. Call blocking is more common at 64K than 56K. During the experiment, check to see if you have any reliability issues. The **set speed auto** command tells the router to try 64K. However, only a 64K end-to-end data path will work. If you are blocked, try again at 56K.
4. This secret client password must match the password configured on hq-sanjose. For example, the password "tahoe-pw" is in the central site's **username soho-tahoe password tahoe-pw** command. See the section "Configuring Site Definitions" in the chapter "Cisco AS5300 Configuration."

Verify

To verify the configuration:

- Enter the **show security** command to view the security parameters associated with the hq-sanjose profile. Notice that the Cisco 766 is not configured to support PAP.

```
soho-tahoe:hq-sanjose> show security

Profile Parameters
    PPP Security
      PPP Authentication OUT      NONE<*>
      PPP Authentication ACCEPT   EITHER
      Token Authentication Support
        TAS Mode                  OFF
        TAS Client                0.0.0.0
        Use Local CHAP Secret     ON
      Client
        User Name                 soho-tahoe
        PAP Password              NONE
        CHAP Secret               EXISTS
      Host
        PAP Password              NONE
        CHAP Secret               EXISTS
      Callback
        Request                   OFF
        Reply                     OFF
```

- Enter the **show configuration** command to view the configuration settings for the hq-sanjose profile. Notice that bridging is turned off and IP routing is on. The dialed number for each channel is displayed. Hq-sanjose's phone number is 4085551234.

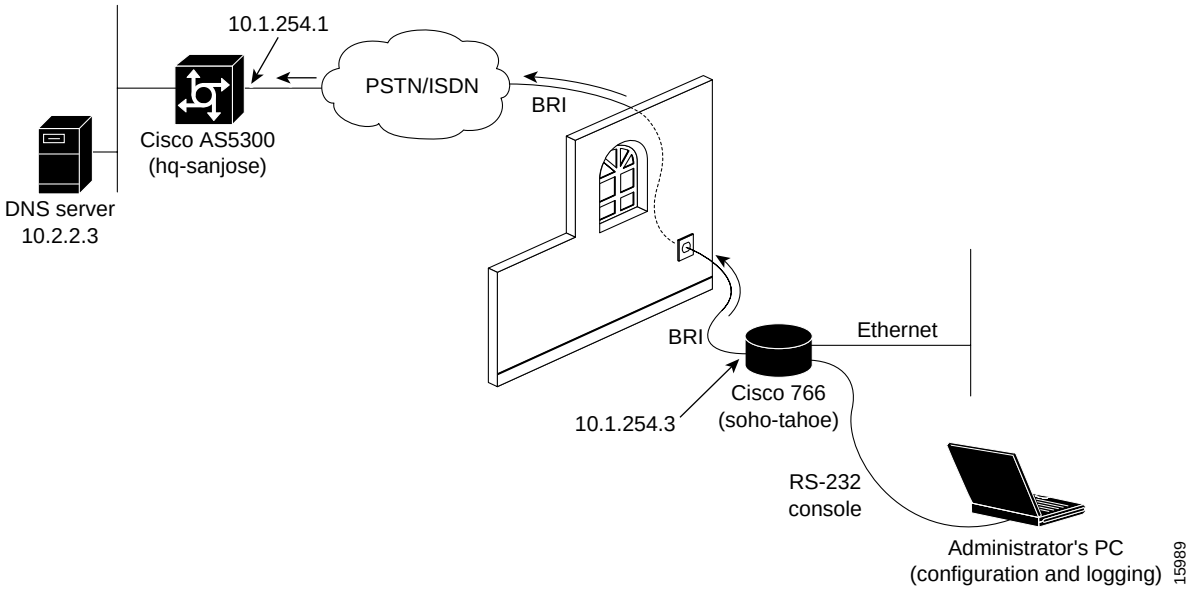
```
soho-tahoe:hq-sanjose> show configuration

Profile Parameters
    Bridging Parameters
      Bridging              OFF<*>
      Routed Protocols      IP <*>
      Learn Mode            ON
      Passthru              OFF
    Call Startup Parameters
    Line Parameters
      Line Speed            AUTO
      Numbering Plan        NORMAL
    Call Parameters         Link 1            Link 2
      Auto                    ON                  ON
      Called Number      14085551234<*>     14085551234<*>
      Backup Number
```

```
  Ringback Number
  CLI Validate Number
CLICallback             OFF
CLIAuthentication       OFF
```

Step 4—Testing Connections to the Cisco AS5300

This section describes how to perform the test. Figure 4-2 shows the actual test lab environment used in this test case.

Figure 4-2 Test Lab Environment



Step 1 Look at the routing table. Enter the **show ip route** command to verify that the correct routes are set up. Before you try to use IP, you should verify that IP will work.

View this information in the hq-sanjose profile and at the system level. If the profile is shut down, you will not see the route at the system level.

```
soho-tahoe:hq-sanjose> show ip route
Profile         Type Destination     Bits Gateway         Prop Cost Source Age
-------------------------------------------------------------------------------
hq-sanjose      NET  10.1.254.0       24   DIRECT           ON   1   DIRECT  0

soho-tahoe:hq-sanjose> cd
soho-tahoe> show ip route
Profile         Type Destination     Bits Gateway         Prop Cost Source Age
-------------------------------------------------------------------------------
LAN             NET  10.1.3.0          24   DIRECT           ON   1     DIRECT 0
hq-sanjose      NET 10.1.254.0         24   DIRECT           ON   1     DIRECT 0
```

Step 2 Change to the hq-sanjose profile. Enter the **show connection** command. Verify that no calls are currently connected:

```
soho-tahoe> cd hq-sanjose
soho-tahoe:hq-sanjose> show connection
Connections    01/01/1998 00:04:47
    Start Date & Time   #  Name                #     Ethernet
  1 01/01/1998 00:00:00 #                      # 00 00 00 00 00 00
  2 01/01/1998 00:02:36 #                      # 00 00 00 00 00 00
```

Step 3 Call hq-sanjose manually by entering the **call ch2** command. Notice that the call must be initiated from within the hq-sanjose profile:

```
soho-tahoe:hq-sanjose> call ch2
01/01/1998 00:04:50  L05  0 14085551234 Outgoing Call Initiated
01/01/1998 00:04:53  L08  2 14085551234 Call Connected
01/01/1998 00:04:53  Connection 2 Add     Link 1 Channel 2
```

Step 4 Ping the DNS server, which is behind hq-sanjose and might be several hops away. If it fails, move back and try to ping the closest router (10.1.254.1).

```
soho-tahoe:hq-sanjose> ping 10.2.2.3
Start sending:   round trip time is 100 msec.
```

Step 5 Enter the **show connection** command to verify that the second connection is up:

```
soho-tahoe:hq-sanjose> show connection
Connections    01/01/1998 00:05:42
    Start Date & Time   #  Name                #     Ethernet
  1 01/01/1998 00:00:00 #                      # 00 00 00 00 00 00
  2 01/01/1998 00:02:36 # hq-sanjose           #
            Link: 1 Channel: 2 Phone: 14085551234
```

Step 6 Enter the **show status** command:

```
soho-tahoe> show status
Status    01/01/1998 00:47:50
Line Status
  Line Activated
  Terminal Identifier Assigned    SPID Accepted
  Terminal Identifier Assigned    SPID Accepted
Port Status                                      Interface Connection Link
  Ch:  1   56K Call In Progress        14085551234       DATA          2      1
  Ch:  2      Waiting for Call
```

Step 7 Try pinging the DNS server from a test PC on the local Ethernet LAN. Open the DOS application and enter the **ping** command.

```
Microsoft(R) Windows 95
   (C)Copyright Microsoft Corp 1981-1996.

C:\WINDOWS> ping 10.2.2.3
Pinging 10.1.3.2 with 32 bytes of data:

Reply from 10.1.3.2: bytes=32 time=3ms TTL=236
Reply from 10.1.3.2: bytes=32 time=2ms TTL=236
Reply from 10.1.3.2: bytes=32 time=3ms TTL=236
Reply from 10.1.3.2: bytes=32 time=2ms TTL=236
```

Troubleshooting and Debugging Tips

- Sometimes calls fail because the public phone network is blocking the call, which is beyond your control. Look at the B channel LEDs on the router. If the CH1 light is flashing, it means that the router is trying to place a call. Be patient and wait for the call to go through.
- If problems persist, have the local administrator connect to the command line interface (CLI) of the Cisco700 using telnet or a directly attached console to use various **show** commands, as described in the next bullet.
- Use **log** commands to enhance the output to the CLI. For example, the **log calls verbose** command displays call information on the terminal screen. If calls connect (channel LED on steady) then quickly disconnect, plus you are having serious connection problems, turn on PPP debugging by entering the **diag ppp on** | **off** command. Be sure to set **diag ppp off** when the function is not in use by an administrator.

Step 5—Confirming the Final Running Configuration

Here is the final configuration running on the Cisco 766. This configuration file can be used as a basic template for turning up additional remote sites. The **bold** entries are site specific. They should be customized for each site.

Timesaver You can save time configuring a Cisco 766 by pasting a configuration file directly into a router. To do this, first return the router to its default state using the **set default** command. The router has no running configuration after this command is entered. Next, paste in the configuration file.

```
set system soho-tahoe
set switch ni1
set 1 spid 53055580840101
set 2 spid 53055580850101
set 1 directorynumber 5558084
set 2 directorynumber 5558085
set phone1 5558084
set phone2 5558085
set voice out conditional
set voice in conditional
set ppp multilink on
set ppp authentication incoming chap
set ppp secret host
tahoe-pw
tahoe-pw
set password system
admin-pw
admin-pw
cd lan
set ip address 10.1.3.1
set ip netmask 255.255.255.0
set ip routing on
set ip rip update off
set bridging off
cd
set user hq-sanjose
set prof power=activate user=hq-sanjose
cd hq-sanjose
set active
set encap ppp
set ip routing on
set ip framing none
set ip address 10.1.254.3
```

```
set ip netmask 255.255.0.0
set ip pat off
set ip rip update off
set ip route destination 0.0.0.0 gateway 10.1.254.1
set bridging off
set number 14085551234
set speed 56
set ppp authentication outgoing none
set ppp authentication incoming chap
set ppp secret client
tahoe-pw
tahoe-pw
cd
reboot
```

After you verify that the configuration works, initiate an upload at the end of the session and save it. An upload displays the setting of every configuration parameter on the Cisco 766.

```
soho-tahoe> upl
CD
SET SCREENLENGTH 20
SET COUNTRYGROUP 1
SET LAN MODE ANY
SET WAN MODE ONLY
SET AGE OFF
SET MULTIDESTINATION OFF
SET SWITCH NI-1
SET 1 SPID 53055580840101
SET 1 DIRECTORYNUMBER 5558084
SET PHONE1 = 5558084
SET 2 SPID 53055580850101
SET 2 DIRECTORYNUMBER 5558085
SET PHONE2 = 5558085
SET AUTODETECTION  OFF
SET CONFERENCE 60
SET TRANSFER 61
SET 1 DELAY 30
SET 2 DELAY 30
SET BRIDGING ON
SET LEARN ON
SET PASSTHRU OFF
SET SPEED AUTO
SET PLAN NORMAL
SET 1 AUTO ON
SET 2 AUTO ON
SET 1 NUMBER
SET 2 NUMBER
SET 1 BACKUPNUMBER
SET 2 BACKUPNUMBER
SET 1 RINGBACK
SET 2 RINGBACK
SET 1 CLIVALIDATENUMBER
SET 2 CLIVALIDATENUMBER
SET CLICALLBACK OFF
SET CLIAUTHENTICATION OFF
SET SYSTEMNAME SOHO-TAHOE
LOG CALLS TIME VERBOSE
SET UNICASTFILTER OFF
DEMAND 1 THRESHOLD 0
DEMAND 2 THRESHOLD 48
DEMAND 1 DURATION 1
DEMAND 2 DURATION 1
DEMAND 1 SOURCE LAN
DEMAND 2 SOURCE BOTH
TIMEOUT 1 THRESHOLD 0
```

```
TIMEOUT 2 THRESHOLD 48
TIMEOUT 1 DURATION 0
TIMEOUT 2 DURATION 0
TIMEOUT 1 SOURCE LAN
TIMEOUT 2 SOURCE BOTH
SET PASSWORD SYSTEM ENCRYPTED 0500120632484048
SET REMOTEACCESS PROTECTED
SET LOCALACCESS ON
SET CLICKSTART ON
SET LOGOUT 5
SET CALLERID OFF
SET PPP AUTHENTICATION IN CHAP
SET PPP CHAPREFUSE NONE
SET PPP AUTHENTICATION OUT NONE
SET PPP AUTHENTICATION ACCEPT EITHER
SET PPP TAS CLIENT 0.0.0.0
SET PPP TAS CHAPSECRET LOCAL ON
SET PPP SECRET HOST ENCRYPTED 10471a1d0b43191f4d45
SET PPP CALLBACK REQUEST OFF
SET PPP CALLBACK REPLY OFF
SET PPP NEGOTIATION INTEGRITY 10
SET PPP NEGOTIATION COUNT 10
SET PPP NEGOTIATION RETRY  3000
SET PPP TERMREQ COUNT 2
SET PPP MULTILINK ON
SET COMPRESSION STAC
SET PPP BACP ON
SET PPP ADDRESS NEGOTIATION LOCAL OFF
SET PPP IP NETMASK LOCAL OFF
SET IP PAT UDPTIMEOUT 5
SET IP PAT TCPTIMEOUT 30
SET IP RIP TIME 30
SET CALLDURATION 0
SET SNMP CONTACT ""
SET SNMP LOCATION ""
SET SNMP TRAP COLDSTART OFF
SET SNMP TRAP WARMSTART OFF
SET SNMP TRAP LINKDOWN OFF
SET SNMP TRAP LINKUP OFF
SET SNMP TRAP AUTHENTICATIONFAIL OFF
SET DHCP OFF
SET DHCP DOMAIN
SET DHCP NETBIOS_SCOPE
SET VOICEPRIORITY INCOMING INTERFACE PHONE1 CONDITIONAL
SET VOICEPRIORITY OUTGOING INTERFACE PHONE1 CONDITIONAL
SET CALLWAITING INTERFACE PHONE1 ON
SET VOICEPRIORITY INCOMING INTERFACE PHONE2 CONDITIONAL
SET VOICEPRIORITY OUTGOING INTERFACE PHONE2 CONDITIONAL
SET CALLWAITING INTERFACE PHONE2 ON
SET CALLTIME VOICE INCOMING OFF
SET CALLTIME VOICE OUTGOING OFF
SET CALLTIME DATA INCOMING OFF
SET CALLTIME DATA OUTGOING OFF
SET USER LAN
SET BRIDGING OFF
SET IP ROUTING ON
SET IP ADDRESS 10.1.3.1
SET IP NETMASK 255.255.255.0
SET IP FRAMING ETHERNET_II
SET IP PROPAGATE ON
SET IP COST 1
SET IP RIP RECEIVE V1
SET IP RIP UPDATE OFF
SET IP RIP VERSION 1
SET USER Internal
```

```
SET IP FRAMING ETHERNET_II
SET USER Standard
SET PROFILE ID 000000000000
SET PROFILE POWERUP ACTIVATE
SET PROFILE DISCONNECT KEEP
SET IP ROUTING ON
SET IP ADDRESS 0.0.0.0
SET IP NETMASK 0.0.0.0
SET IP FRAMING NONE
SET IP RIP RECEIVE V1
SET IP RIP UPDATE OFF
SET IP RIP VERSION 1
SET USER HQ-SANJOSE
SET PROFILE ID 000000000000
SET PROFILE POWERUP ACTIVATE
SET PROFILE DISCONNECT KEEP
SET BRIDGING OFF
SET SPEED 56K
SET 1 NUMBER 14085551234
SET 2 NUMBER 14085551234
SET PPP AUTHENTICATION OUT NONE
SET PPP SECRET CLIENT ENCRYPTED 020f175f055204350d0f
SET IP ROUTING ON
SET IP ADDRESS 10.1.254.3
SET IP NETMASK 255.255.0.0
SET IP FRAMING NONE
SET IP PROPAGATE ON
SET IP COST 1
SET IP RIP RECEIVE V1
SET IP RIP UPDATE OFF
SET IP RIP VERSION 1
SET IP PAT OFF
SET IP ROUTE DEST 0.0.0.0/0 GATEWAY 10.1.254.1 PROPAGATE OFF COST 1
CD
SET BUTTON Standard
LOGOUT
```

IP, IPX, and AppleTalk Dial-Up Environments

Remote node users are telecommuters and mobile users who need to dial in to a network from their PC or Macintosh computer, through an access server in to IP, IPX, or AppleTalk networks to access network resources. This chapter describes the following scenarios:

- Getting a PC to dial in to a network by using a PPP application to access IP resources
- Getting a PC to dial in to a network by using a PPP application to access Novell IPX resources
- Getting a Macintosh to dial in to a network by using ARA to access AppleTalk and IP Resources

---

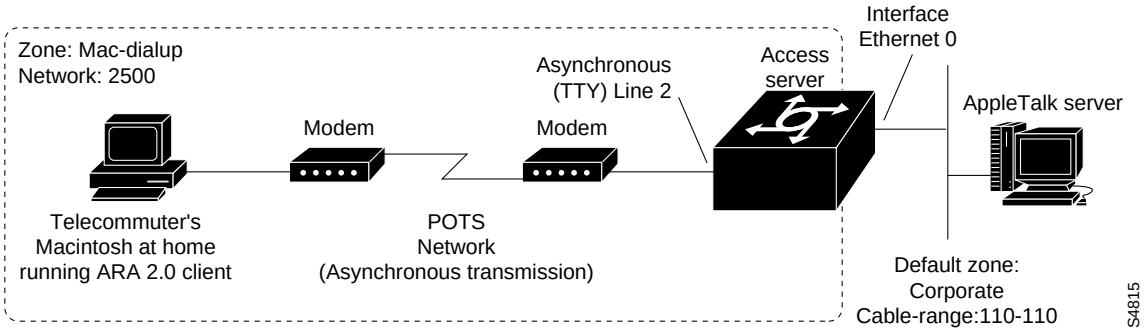
Note This guide does not describe how to configure SLIP. For more information about SLIP, refer to the *Dial Solutions Configuration Guide*. For popular configuration tips gathered by Cisco's Technical Assistance Center (TAC), go to the "Sample Configurations" home page at http://www.cisco.com/warp/public/700/tech_configs.html.

Each configuration in this chapter builds on preceding configurations from previous chapters. It presents the whole configuration required to enable dial-in and configure security for each of the scenarios. Thus far, this guide has described how to configure the following on your access server:

- Autoselect
- Group asynchronous interfaces
- Modem dial-in
- Security

When a remote PC or Macintosh computer dials in to a network, it is considered a "node" on the LAN to which it is connecting. This is the case for each dial-in session, whether the device dialing in is a PC, Macintosh, or other computer. The IP address of a PC, for example, is selected from those available on the subnet assigned to the network that the PC is connecting to. In Figure 5-1, for example, the telecommuter's Macintosh is a node in the AppleTalk network 2500 in the zone Mac-dialup, and is treated like a local host.

Figure 5-1 Remote Macintosh as a Node on the Local Network



In router-to-router configurations (such as between a remote and central office), the remote device (PC or Macintosh computer) is not considered a node on the LAN that it is dialing in to. That is, the remote computer is on a different LAN and has an IP address that is not chosen from those available on the local network. These configurations are typically more complex and require use of the dial-on-demand routing (DDR) facility in the Cisco IOS software. For more information, refer to the chapter “Routing across Modem Lines” later in this guide.

Configuring Point-to-Point Protocol (PPP) Access

This section describes how to configure your access server to accept calls into IP and IPX networks from clients (PCs) using PPP to access resources such as file servers and printers. It also describes how to allow Macintosh or PC clients running a PPP application to dial in to an AppleTalk network.

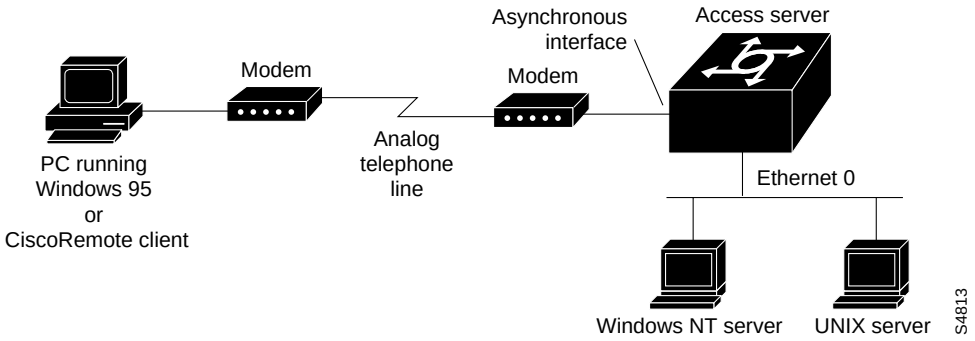
Specifically, this section describes the following:

- Accessing IP Resources
- Configuring NetBIOS over TCP
- Enabling PPP Clients to Dial In and Access AppleTalk Resources
- Accessing IPX Resources
- Setting up Windows 95 on the Remote PC Side of the Connection

Accessing IP Resources

This section describes how to configure the access server to accept calls in to an IP network so that clients (remote PC computers) can access IP resources, such as a Windows NT server. It describes first the access server configuration, then presents some basic configuration information for the dial-in client. Figure 5-2 shows a typical dial-in scenario.

Figure 5-2 PC Dialing In to Access IP Network Resources



In Figure 5-2, a remote telecommuter dialing through the access server uses the Windows 95 client to access the Windows NT server. The client is considered a node on the same network as the NT server.

Enabling IP Network Protocol Support

To dial in to an IP network by using PPP, you first need to enable the network protocol support. IP routing is enabled by default in the Cisco IOS software. However, if you have a routing protocol running on the LAN to which the access server provides access, you must specify this protocol in the access server's configuration, as well. This guide and the following procedure assume you are configuring OSPF routing. If so, perform the following steps to enable IP network support:

Note If you are using a routing protocol other than OSPF, refer to the *Network Protocols Configuration Guide, Part 1* in the Cisco IOS configuration guides and command references documentation.

Step 1 Enter privileged EXEC and global configuration mode on the access server named *2511*.

```
2511> enable
Password:
2511# configure terminal
2511(config)#
```

Step 2 If you haven't done so already, specify the IP address of the Ethernet interface on the access server. This should be a valid, unique, and unused IP address for a subnet on a connected LAN.

```
2511(config-router)# interface ethernet 0
2511(config-if)# ip-address 172.16.42.24 255.255.255.0
```

Step 3 Enable OSPF routing (assuming a routing process is given the number 101):

```
2511(config-if)# router ospf 101
2511(config-router)#
```

Step 4 Define the IP address of the Ethernet interface on which OSPF runs and define the area ID for that interface:

```
2511(config-router)# network 172.16.42.24 0.0.0.255 area 0
```

Step 5 Configure an OSPF network type of point-to-multipoint on the Ethernet interface 0 on the access server:

```
2511(config-router)# interface ethernet 0
2511(config-if)# ip ospf network point-to-multipoint
```

Step 6 Identify the IP domain name and IP name server on the LAN segment:

```
2511(config-if)# exit
2511(config)# ip domain-name eapp.com
2511(config)# ip name-server 172.16.42.128
```

To configure IGRP instead of OSPF routing, issue the **router igrp** *process-id* global configuration command, then associate the network with the IGRP process ID by issuing the **network** *address* router configuration command. For example, you enter the following commands to configure IGRP routing:

```
2511(config-if)# router igrp 101
2511(config-router)# network 172.16.42.0
```

You can also configure a number of other routing protocols with IP, including RIP, IS-IS, BGP, EGP, GDP, IRDP, and IP multicast routing. For more information about configuring any of these routing protocols, refer to the *Network Protocols Configuration Guide, Part 1* in the Cisco IOS documentation.

Configuring PPP Encapsulation

To enable IP dial-in, configure PPP encapsulation on asynchronous interfaces, as follows:

Step 1 To conserve IP addresses, configure the asynchronous interfaces as unnumbered and assign the IP address of the Ethernet interface to them:

```
2511(config)# interface group-async2
2511(config)# group-range 1 16
2511(config-if)# ip unnumbered ethernet0
```

Step 2 Specify PPP encapsulation on asynchronous interfaces to which you will allow PPP connections:

```
2511(config-if)# encapsulation ppp
```

Step 3 Enable interactive mode on asynchronous interfaces:

```
2511(config-if)# async mode interactive
```

Step 4 Configure lines on the access server to detect incoming PPP packets and permit a PPP client to connect to the network automatically. The following example shows lines 1 to 8 on an access server being configured to autoselect incoming PPP packets:

```
2511(config-if)# line 1 8
2511(config-line)# autoselect ppp
```

Note You do not need to configure autoselect for incoming PPP packets. You can issue the **async mode dedicated** command in place of the **async mode interactive** command. If you use dedicated asynchronous mode on a set of interfaces, users are not automatically connected to the network. Rather, they are connected to the EXEC facility on the access server, and then they must issue the **ppp** command to connect to network resources. For more information, refer to the *Dial Solutions Configuration Guide* in the Cisco IOS documentation.

Assigning IP Addresses to Dial-In Clients

This section describes the methods you can use to assign IP addresses to dial-in clients. The methods are as follows:

- Method 1: Obtain Addresses from a Pool Configured in the Access Server

  This is the simplest mechanism for assigning IP addresses to dial-in clients and is most useful when there is only one access server providing access to the network. A set of IP addresses is defined in a database that exists inside the access server. If there is more than one access server providing access to the network, you should refer to method 2.

- Method 2: Obtain Addresses from a Pool Configured in a DHCP Server

  This is the next most convenient method, and is most useful for a medium to large-size pool of dial-in clients. A pool of IP addresses is defined inside of a centralized IP address server, called a Dynamic Host Configuration Protocol (DHCP) server. This central database can serve addresses to several different access servers at the same time. Although this method provides long-term flexibility, it requires that you configure a third-party host (such as a UNIX computer) as a DHCP server.

- Method 3: Assign Static IP Addresses to Each PC

  This is the least efficient most time-consuming method of assigning IP addresses to clients. As clients are added, removed, and moved in the network, IP addresses must be reassigned.

Method 1: Obtain Addresses from a Pool Configured in the Access Server

To configure the address pool locally on the access server, perform the following steps:

Step 1 Create a local IP address pooling mechanism in the access server:

```
2511(config)# ip address-pool local
```

Step 2 Assign a pool of specific IP addresses in a pool (addresses 172.16.80.0 through 172.16.80.16 in pool1):

```
2511(config)# ip local pool pool1 172.16.80.1 172.16.80.16
```

The address pool named pool1 is applied automatically to each asynchronous interface configured for point-to-point access, so you do not have to apply it manually. If you need to apply this pool manually to asynchronous interfaces, issue the **peer default ip-address pool pool1** interface configuration command.

For a comprehensive configuration example of PPP dial-in to an IP network, refer to the section "Dial-In Configuration Examples" later in this chapter.

Method 2: Obtain Addresses from a Pool Configured in a DHCP Server

To configure the access server to obtain IP addresses from a DHCP server, perform the following steps:

Step 1 Configure asynchronous interfaces on an access server to assign IP addresses to dial-in clients from a DHCP server (in this example, a group async interface is configured):

```
2511(config)# interface group-async 1
2511(config-if)# peer default ip-address dhcp
```

Step 2 Configure the Cisco IOS software to query a DHCP server for IP addresses that can be supplied to IP clients as they dial in:

```
2511(config)# ip address-pool dhcp-proxy-client
```

You also must configure the client software on client PCs to obtain IP addresses from a DHCP server. Refer to the documentation that accompanied the PC client software for more information about configuring IP addressing options.

For a comprehensive configuration example for PPP dialing to an IP network, refer to the section "Dial-In Configuration Examples" later in this chapter.

Method 3: Assign Static IP Addresses to Each PC

To configure the access server to statically define IP addresses to each client dialing in to the network, enter interface configuration mode and issue the **peer default ip address** *address* command, as shown in the following example:

```
2511(config)# interface async 1
2511(config-if)# peer default ip-address 172.16.42.26
```

Note To prevent duplicate IP addresses from being assigned on two or more interfaces, you cannot assign a static IP address to a group asynchronous interface. A single IP address on a group asynchronous interface permits assignment of the same address to more than one dial-in client. For the same reason, this command also cannot be applied to dialer rotary groups or to ISDN interfaces.

The IP address you assign must be the same as the address specified on the remote dial-in client. Refer to the documentation that accompanied the PC client software for more information about configuring IP addressing options.

For a comprehensive configuration example for PPP dialing to an IP network, refer to the section "Dial-In Configuration Examples" later in this chapter.

Configuring Other IP Dial-in Parameters

Though optional, you generally identify the IP domain name and IP name server on the LAN segment, as shown in the following example:

```
2511(config)# ip domain-name eapp.com
2511(config)# ip name-server charlatan
```

Table 5-1 lists other parameters that are often useful for administrators configuring IP dial-in using PPP.

Table 5-1 Additional PPP Dial-in Parameters

Command	Purpose
ip tcp header-compression passive (interface configuration command)	Instructs the access server port to perform compression of TCP headers if requested by the client.
asynchronous dynamic address (interface configuration command)	(IP only.) Enables the client to select an IP address dynamically when dialing in.

Caution If you have configured network protocol support, PPP encapsulation, and an IP addressing method, IP clients can dial in to your network. Ensure that you configure security, as described in the chapter "Security Configuration" in this guide. Also, the configuration examples at the end of this chapter show IP configuration examples with security.

Configuring NetBIOS over TCP

To enable clients running NetBIOS over TCP to dial in to IP network resources, perform the following tasks on the access server:

Step 1 Specify a hostname or IP address of your Wins server on the network:

```
2511(config)# async-bootp nbns-server 172.18.42.8
```

Step 2 If you have one or more domain name servers on the network, specify a host name or IP address of that domain name server:

```
2511(config)# async-bootp dns-server 172.18.42.12 172.18.42.10
```

Make sure you have the following in your NetBIOS network:

- A Microsoft Windows domainized environment
- A Wins server
- A primary domain controller (logon controller)

For more information about configuring your Windows NT environment, refer to your Microsoft documentation or online resource, such as the World-Wide Web page “Microsoft TechNet” at the following URL: http://www.microsoft.com/TechNet/.

Enabling PPP Clients to Dial In and Access AppleTalk Resources

To enable PPP clients using PPP applications to access AppleTalk resources on a network, first perform the following tasks, as described in the earlier section “Accessing IP Resources.”

- Assign an IP address to an Ethernet interface
- Enable PPP encapsulation on all asynchronous interfaces that will accept calls from PPP clients that need to access AppleTalk resources.

Note AppleTalk routing is not supported on asynchronous interfaces configured for PPP that allow IP clients to access AppleTalk resources.

Next, perform the following steps:

Step 1 Create an internal network on the access server by issuing the **appletalk virtual-net** command. The internal network number and zone name also can be used for dial-in using ARA (but do not need to be the same).

```
2511(config)# appletalk virtual-net 101 ara-dialin
```

Step 2 Enable AppleTalk client mode on asynchronous interfaces configured for PPP dial-in. The following example shows client mode configured on a group asynchronous interface.

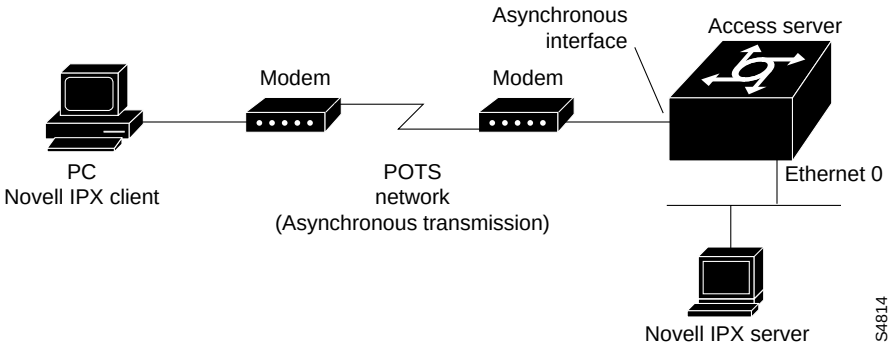
```
2511(config)# interface group-async1
2511(config-if)# appletalk client-mode
```

At this point, PPP clients can dial in to a network and access AppleTalk resources, such as AppleShare servers and printers.

Accessing IPX Resources

This section describes how to configure the access server to accept calls in to an IPX network so that clients can access IPX resources, such as a Novell IPX server. It describes first the access server configuration, then presents some basic configuration information for the dial-in client. Figure 5-3 shows a typical dial-in scenario.

Figure 5-3 PC Dialing In to Access IPX Network Resources



In Figure 5-3, a remote telecommuter dialing through the access server uses the Novell IPX client to access the Novell IPX server. The client is a node on the same network as the IPX server.

Enabling IPX Network Protocol Support

For PPP dialing to an IPX network, you must first enable network protocol support. This includes enabling IPX routing on the access server. If the dial-in client will be a routing client, you also must specify the routing protocol running on the LAN to which the access server provides access. To enable IPX network protocol support, perform the following steps:

Step 1 Enable IPX routing on the access server.

```
2511(config)# ipx routing 0060.3ef1.6f74
```

Note In the preceding step, the MAC address (0060.3ef1.6f74) is added automatically, based on the MAC address of the Ethernet interface on the access server. You only need to issue the **ipx routing** command if you want to assign a different MAC address. The MAC address is shown in the preceding step only for illustrative purposes.

Step 2 If you are configuring IPX only and not IP, configure the Ethernet interface 0 as IP unnumbered.

```
2511(config)# interface Ethernet0
2511(config-if)# ip unnumbered
```

However, if you are configuring IP and IPX on the interface, you must provide an IP address for Ethernet interface 0. This must be a valid, unique, and unused IP address for a subnet on a connected LAN.

```
2511(config)# interface Ethernet0
2511(config-if)# ip address 172.21.14.64 255.255.255.0
```

Step 3 Set the IPX network number and encapsulation to match your existing network. The following example shows network 123ABCD and an encapsulation type of SAP:

```
2511(config-if)# ipx network 123ABCD encapsulation SAP
```

Step 4 If the client connecting to the network is *not* performing routing, you do not have to enable a routing protocol and can skip to the next step. If the client connecting to the network is performing routing, configure a routing protocol. RIP routing is enabled by default. To specify a different routing protocol, such as Enhanced IGRP or NLSP, enter the **ipx router** command, followed by the name of the routing protocol.

The first example shows how to enable Enhanced IGRP routing with an autonomous system number of 1205. Enhanced IGRP is usually used in large networks.

```
2511(config)# ipx router eigrp 1205
```

The next example shows how to enable NLSP routing with an NLSP process tag of 210. An NLSP tag is optional if there is only one NLSP process. The process of configuring NLSP is somewhat complex and you must add NLSP servers to the network.

```
2511(config)# ipx router nlsp 210
```

Creating a Loopback Interface for Novell IPX Network Numbers

If you allow remote clients to dial in to IPX network resources, you should create a loopback interface, which is a "virtual" interface existing only in the router. Assign a Novell IPX network number to this loopback interface, then assign this network number to each asynchronous interface. The alternative is to assign a unique Novell IPX network number to each asynchronous interface, which could consume hundreds of Novell IPX network numbers. This section assumes that nonrouting clients are dialing in to access IPX network resources.

Note Follow these steps only if you IPX clients are nonrouting clients. If they are routing clients, you *must* assign a unique IPX network number to each asynchronous interface and you cannot use group asynchronous interfaces, because there is no way to assign a unique IPX network number to each interface in a group.

Step 1 Create a loopback interface:

```
2511(config-if)# interface Loopback0
```

Step 2 Do not require an IP address on the Loopback interface 0:

```
2511(config-if)# no ip address
```

Step 3 Assign a Novell IPX network number (in this case, 1F) to the loopback interface:

```
2511(config-if)# ipx network 1F
```

Configuring the Asynchronous Interfaces

This section assumes you are configuring group asynchronous interfaces.

After you configure IPX network support and a loopback interface, you then configure the asynchronous interfaces for PPP and assign the Novell IPX network number of the loopback interface to the asynchronous interface. You can also enable interactive mode on the interfaces.

Step 1 Assign the IP address of the Ethernet interface to a single master or each asynchronous interface:

```
2511(config-if)# ip unnumbered ethernet0
```

Step 2 Specify PPP encapsulation on asynchronous interfaces to which you need to allow PPP connections:

```
2511(config-if)# encapsulation ppp
```

Step 3 Assign the Novell IPX network number of the loopback interface to the group asynchronous interface.

```
2511(config-if)# ipx ppp-client loopback0
```

Step 4 (Optional) Filter SAP routing updates on asynchronous interfaces. SAP updates take up a great deal of bandwidth, and asynchronous interfaces have low bandwidth.

```
2511(config-if)# ipx sap-interval 0
```

Step 5 Enable interactive mode. Interactive mode enables you to support services other than PPP (such as EXEC sessions, SLIP, or ARA).

```
2511(config-if)# async mode interactive
```

IPX Client Addressing

The Cisco IOS software assumes that all PCs dialing in have their own unique IPX address and that they send this address to the access server.

Configuring Other IPX Dial-in Parameters

For additional parameters that enable PPP dial-in to IPX networks, refer to Table 5-1.

Note At this point, IPX clients can dial in to your network. Ensure that you configure security, as described in the chapter “Security Configuration” in this guide. The configuration examples at the end of this chapter show IPX configuration examples with basic security.

Setting up Windows 95 on the Remote PC Side of the Connection

This section describes how to install and configure Windows 95 client software to dial in to and access network resources through a Cisco access server.

If you need information about configuring the CiscoRemote client software, you can receive a fax-back document from the Cisco Technical Assistance Center at 800 553-2447 or 408 526-7209 or call directly into the fax-on-demand service at 415 596-4408.

You can use virtually any other dial-in client applications to dial in to a network through access servers.

This configuration procedure is intended only as a starting point. The configuration requirements can change without warning because Cisco does not control the design and development efforts of other companies. This configuration information is only one of many ways of configuring a Win95 client application for dial-in using PPP. To set up the built-in PPP application in Win95 so that you can access the ISP's IP or NetBEUI network resources, perform the following steps:

Step 1 Double-click on the My Computer icon located either in your Applications window or on the desktop.

The My Computer window appears.

Step 2 If you are making a connection for the first time, double-click on the Make a New Connection icon. If you have already configured your connection profiles, additional icons exist in this window and you can double-click on them to use them.

Step 3 Give the connection session a name, such as MyConnection.

Step 4 Select the type of modem connected to your PC (or built in to the PC) from the list of modems.

Step 5 When the dialog box appears, click on the Configure button.

The General, Connection, and Options folders appear stacked on top of one another. You can select each tab to configure the appropriate parameters.

Step 6 Select the Connection tab. In the Connection folder, set data bits to 8, parity to No, and stop bits to 1, then click Apply.

The Advanced Connection Settings window appears.

Step 7 Modems usually perform all the data compress you'll ever need. However, if you have a very old modem, you should Select Data Compression and Hardware flow control and click OK.

Step 8 Select the Options tab. In the Options folder, select "Bring up terminal window after dialing" and click on the Next button.

The option "Bring up terminal window after dialing" means that when you dial in, the access server prompts you for your username and password, then logs you in to the EXEC facility.

A new dialog box appears that indicates you have finished configuring a dialup profile and the Myconnection connectoid appears.

Step 9 Click on the Next button.

Step 10 In the Phone Number field, enter the phone number, area code, and country of the access server you intend to dial and press Return.

You have configured preliminary parameters to enable the Win95 client to dial in to an access server. At this point, you need to define additional properties.

Step 1 Select the dialup profile connectoid, then click with the right mouse button, and pull down the menu. Select Properties.

Step 2 In the Properties dialog box, select Server_Type.

The ServerTypes dialog box appears, as shown in Figure 5-4.

Figure 5-4 Windows 95 Server Types Dialog Box

Step 3 Select PPP Windows 95 Windows NT 3.5 Internet.

Step 4 In the Allowed Network Protocols area of the dialog box, select TCP/IP if you intend to function as an IP client to access IP network resources.

Step 5 Select the TCP/IP Settings pull-down menu at the bottom right corner of the dialog box.

Step 6 Select Server assigned IP and Name server addresses if you are getting your addresses from a server. Otherwise, enter an IP address.

Step 7 Select Use default gateway on remote network. Click Apply. Select IP compression if you also intend to enable header compression of IP packets on the access server, which is enabled with the **ip tcp header-compression passive** interface configuration command.

Step 8 Go to the Control Panel and select Internet.

Step 9 Check the AutoDial checkbox if your PPP connection is the only modem or ISDN connection to the Internet. Uncheck this box if you have more than one outgoing connection.

Step 10 Select MyConnection and click on the Apply button.

When you start an application that requires network access, you are prompted for a username and password. This username and password must match the username and password on the access server. When you select Connect, the client dials the number you entered. In a status box, you can see the information *dialing*, *verifying username/password*, and the dial-in application should run without problems. Figure 5-5 shows a successful connection:

Figure 5-5 Windows 95 Connection Status Box

Configuring AppleTalk Remote Access (ARA) for Macintosh Access

This section describes how to configure the access server to accept calls in to an AppleTalk network so that clients can access AppleTalk resources, such as an AppleShare server, a colleague's Macintosh to retrieve files, or a printer. For information about configuring the ARA client, you can receive a fax-back document from Cisco's Technical Assistance Center at 800 553-2447 or 408 526-7209 or call directly into the fax-on-demand service at 415 596-4408.

For information about configuring the access server to enable IP clients to access AppleTalk resources, refer to the later section "Enabling PPP Clients to Dial In and Access AppleTalk Resources." Figure 5-6 shows a typical dial in scenario.

Figure 5-6 Macintosh Dialing In to Access AppleTalk Network Resources

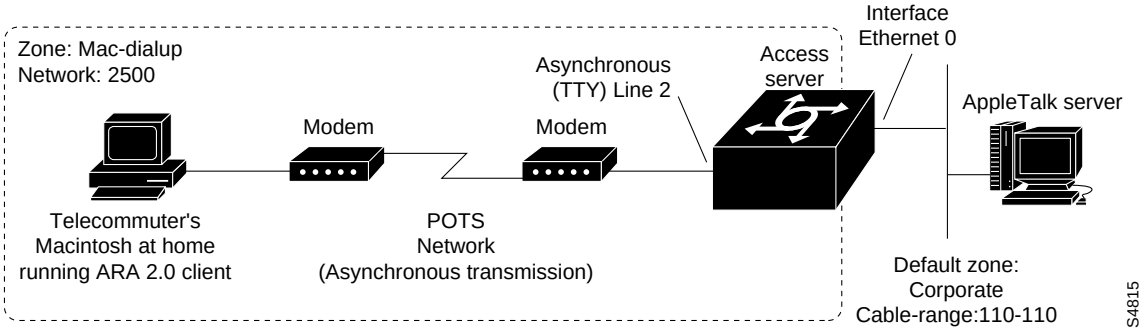


Figure 5-6 shows a Macintosh with ARA 2.0 dialing in to a corporate network through an access server. The Macintosh client is a node on network 2500 in zone Mac-dialup.

After connecting to a corporate network with ARA, clients can also launch applications that enable them to communicate with IP devices, such as UNIX servers, although you must have configured a MacIP server on the network first.

Enabling Macintosh Users to Dial In and Access AppleTalk Resources

The following configuration provides a range of 16 IP addresses, which can be assigned to each of the dial-in remote nodes. The MacIP server resides in the same zone and IP subnet it is providing IP addresses for. This is highly recommended for a gateway server of this kind. The IP address under interface Ethernet 0 strengthens the correlation of subnet to server.

To enable ARA dial in on the access server, perform the following steps:

Step 1 Enable AppleTalk Routing.

```
2511(config)# appletalk routing
```

Step 2 Create a new internal AppleTalk network in the access server. In the following example, the network number is 2500 and the zone name is Mac-dialup.

```
2511(config)# arap network 2500 Mac-dialup
```

Note The nonextended AppleTalk network number used with the **arap network** command must be unique within the AppleTalk intranetwork.

Step 3 Bring up the interface Ethernet 0, assign it an IP address, and configure a cable range. In this example, the cable range is 110 to 110.

```
2511(config)# interface ethernet 0
2511(config-if)# ip address 172.16.42.26 255.255.250.0
2511(config-if)# appletalk cable-range 110-110
```

Step 4 Create an AppleTalk zone on the Ethernet interface 0. In the following example, the zone is given the name Corporate.

```
2511(config-if)# appletalk zone Corporate
```

Step 5 Enter line configuration mode for the lines on which you need to allow ARA clients to dial in and enable ARA. The following example shows lines 1 through 16 being configured for ARA dial in (these are the physical asynchronous TTY lines) and disables guest access to the AppleTalk network.

```
2511(config-if)# line 1 16
2511(config-line)# arap enable
2511(config-line)# autoselect arap
2511(config-line)# arap noguest
```

Step 6 Configure an AppleTalk zone for ARA dial-in sessions. (In Step 4, the zone that was created was Corporate. This example uses the same zone.)

```
2511(config)# appletalk macip server 172.16.42.26 zone Corporate
```

Step 7 Allocate IP addresses for Macintosh users if you are using dynamic addressing

```
2511(config)# appletalk macip dynamic 172.16.42.27 zone Corporate
```

Table 5-2 lists other useful dial-in parameters for ARA.

Table 5-2 Additional ARA Dial-In Parameters

Command	Purpose
arap dedicated	Makes the line only available for ARA dial-in access. Do not issue this command if you are also allowing PPP users to dial in through the line or if you issue the **autoselect ppp** command on the line.
arap timelimit *minutes*	Sets a time limit on dial-in sessions. This prevents clients from staying connected indefinitely.
arap warningtime *minutes*	Sets the amount of time before which the connection is closed because of the **arap timelimit** command. A reasonable amount of time is 15 minutes.

Dial-In Configuration Examples

The configuration examples in this section show comprehensive configurations that enable remote clients to dial in to networks and access resources. The configurations in this section borrow information from the previous chapters and present each component (such as modem configuration and security) as a separate piece. Examples in this section include the following:

- IP Dial-In Example
- IPX Dial-in Example
- ARA Example
- Combined IP–PPP, IPX–PPP, and ARA Example

IP Dial-In Example

The following example configures an access server to enable a PC running a Windows 95 PPP application to dial in to an IP network. It also enables the Windows 95 client to access AppleTalk resources. The example starts with the modem configuration, then moves on to the security configuration, then the protocol configuration. This example assumes that you are using a local username database that is set up inside the access server for authentication.

Modem and Line Configuration

The following sample configures lines 1 through 16 on a Cisco 2511 access server for modem control. It assumes you have a Telebit T3000 modem or one that can be automatically initialized using the Telebit_3000 initialization string.

```
line 1 16
 speed 115200
 flowcontrol hardware
 modem inout
 modem autoconfigure Telebit_t3000
!
 autoselect during-login
 autoselect ppp
!
interface group-async 0
 group-range 1 16
```

Security Configuration

The following sample configuration uses a local authentication database inside the access server. It prevents unauthenticated login to all vty lines. It assumes dial-in users rely on autoselect and do not log in to the EXEC on the access server, but have immediate access to the network when their connection session begins. No security is configured on the console port, which is physically secure. This configuration uses defaults in most cases, except that it uses CHAP authentication for PPP instead of the default of PAP (because CHAP is more secure). It uses the **username** command to populate the local authentication database. The password that appears has been automatically encrypted automatically.

```
aaa new-model
aaa authentication login default local
aaa authentication ppp default local
enable secret 5 $1$h7dd$VTNs4.BAfQMUU0Lrvw6570
enable password cloudcity
!
```

```
username hansolo password 7 095E470B1110
username leiaorga password 7 0215055500070C294D
username anakin password 7 032A5K39068R1935
username jacen password 7 087X2G10385V8148
username jaina password 7 075V3W50429L2943
!
line vty 10 47
 login authentication default
!
line 1 16
 arap authentication default
!
interface Group-Async1
 ppp authentication chap default
 group-range 1 16
```

Protocol Configuration (Using a Local Pool of IP Addresses)

The following sample configuration enables an IP client to dial in to a network via an access server (with an IGRP routing process of 101) and be assigned an IP address from a locally defined pool (from 172.16.80.1 to 172.16.80.200). It also places all 16 asynchronous interfaces in a group interface and PPP encapsulation. IP clients (such as Windows 95 clients) dial in and automatically have a PPP session started (after the security dialog appears).

If you want to obtain IP addresses for dial-in clients from a Dynamic Host Configuration Protocol (DHCP) server, you must change the **peer default ip address pool pool-1** command to **peer default ip address dhcp**. If you want to assign a static address to a remote client, you must change this command (for an address of 172.18.24.48, for example) to **peer default ip address 172.18.24.48**.

```
router igrp 101
 network 172.16.0.0
!
ip address-pool local
ip local pool pool-1 172.16.80.1 172.16.80.200
appletalk virtual-net 101 AT-zone
!
ethernet 0
 ip-address 172.16.42.24 255.255.255.0
!
group-async1
 ip unnumbered ethernet0
 encapsulation ppp
 async mode interactive
 peer default ip address pool pool-1
 ip tcp header-compression passive
 appletalk client-mode
 group-range 1 16
!
ip domain-name eapp.com
ip name-server charlatan
```

IPX Dial-in Example

The following configuration example enables a PC client running a PPP application to dial in to a network and access IPX resources. The modem attached to the access server is a Telebit T3000 modem. For security, the access server uses TACACS+ for lines and asynchronous interfaces and RADIUS for an ISDN interface (attached via an external ISDN terminal adaptor).

Modem and Line Configuration

The following sample configures lines 1 through 16 on a Cisco 2511 access server for modem control. It assumes you have a Telebit T 3000 modem.

```
line 1 16
 speed 115200
 flowcontrol hardware
 modem inout
 modem autoconfigure discovery
 modem autoconfigure type t_3000
!
 autoselect during-login
 autoselect ppp
!
```

Security Configuration

This configuration uses remote security. It uses TACACS+ security for lines and asynchronous interfaces, and RADIUS security for ISDN interfaces. This portion of the configuration only contains security commands. Modem and protocol configuration commands are presented in the sections “Modem and Line Configuration” and “Protocol Configuration.”

```
aaa new-model
aaa authentication login default tacacs+ local
aaa authentication con-special tacacs+ enable
aaa authentication ppp default if-needed tacacs+
aaa authentication ppp use-radius radius
!

enable secret 5 $1$Kv7T$yjdYBYi70X56gOpEtLj.Q.!
!
line 1 16
! Modem commands deleted
 autoselect ppp
 autoselect during-login
!
line con 0
 login authentication con-special
!
interface Group-Async1
 ip unnumbered ether 0
 encapsulation ppp
 async mode interactive
 ppp authentication chap pap default
 group range 1 16
!
interface Group-Async2
 ip unnumbered ether 0
 encapsulation ppp
 async mode interactive
 ppp authentication chap use-radius
 group range 9 16
```

Protocol Configuration

The following sample configuration enables an IPX client to dial in to a network to access IPX resources (IPXCP). In this sample configuration, the IPX client connections are permitted on group asynchronous interface 8, which is associated with loopback interface 0. Loopback interface 0 is configured to run IPX. Routing updates have been filtered on all asynchronous interfaces.

```
ipx routing 0000.0c07.b509
!
loopback0
 no ip address
 ipx network 544
!
interface ethernet0
 ip address 172.21.14.64 255.255.255.0
 ipx network AC150E00
 ipx encapsulation SAP
!
interface group-async1
 ip unnumbered ethernet0
 encapsulation ppp
 async mode interactive
 async default ip address 172.18.1.128
 ipx ppp-client loopback0
 ipx sap-interval 0

interface group-async2
 ip unnumbered ethernet0
 encapsulation ppp
 async mode interactive
 async default ip address 172.18.1.128
 ipx ppp-client loopback0
 ipx sap-interval 0
```

ARA Example

The following example configures an access server to enable a Macintosh running ARA 2.0 to dial in to an AppleTalk network. It also permits IP clients to dial in and access AppleTalk resources. The example starts with the modem configuration, then moves on to the security configuration, then the protocol configuration. This example assumes you are using a local username database that is set up inside the access server for authentication.

Modem and Line Configuration

The following example configures lines 1 through 16 on a Cisco 2511 access server for modem control. It assumes you have a modem that uses an initialization string that corresponds to the Usr_sportster string that is used to configure a modem automatically.

```
line 1 16
 arap enable
 flowcontrol hardware
 modem inout
 modem autoconfigure Usr_sportster
 autoselect during-login
 autoselect arap
!
```

Security Configuration

The following example uses a TACACS+ security database. No security is configured on the console port, which is physically secure. This configuration uses default configuration parameters. ARA authentication permits guests to log in and access network resources.

```
aaa new-model
aaa authentication login default tacacs+
aaa authentication arap default guest tacacs+
enable secret 5 $17dd$VTNs4.BAfQMUU0Lrvw6570
!
line 1 16
 arap authentication default
 login authentication default
```

Protocol Configuration

The following example enables an ARA client to dial in with AppleTalk over PPP (ATCP). ARA clients dial in and automatically have an ARA session started (after the security dialog appears). In this example, IP is enabled on Ethernet interface 0 to allow basic IP connectivity.

```
appletalk routing
arap network 108 dialin14
appletalk virtual-net 107 dialin14
!
ethernet 0
 ip-address 172.16.42.24 255.255.255.0
 appletalk cable-range 20-22
 appletalk zone marketing
!
line 1 16
 arap enable
 arap timelimit 180
 arap warningtime 15
 autoselect arap
 autoselect during-login
!
ip domain-name eapp.com
ip name-server alices-diner
!
! the following commands enable IP clients to dial in and access AppleTalk resources
interface group-async1
 encapsulation ppp
 appletalk client-mode
 group-range 1 16
```

Combined IP–PPP, IPX–PPP, and ARA Example

The following configuration example enables remote clients to dial in to IP, IPX, AppleTalk networks and permits users to log in and connect to the EXEC facility.

Modem and Line Configuration

The following example configures lines 1 through 16 on a Cisco 2511 access server for modem control. It assumes lines 1 through 8 have Hayes Optima modems. (The Cisco IOS software can configure a Hayes Optima modem automatically.)

This configuration assumes that lines 9 through 16 have Practical Peripherals PC28800SA V.42*bis* modems. If you issue the **modem autoconfigure discovery** line configuration command, the Cisco IOS software attempts to identify the modem string that initializes the Practical Peripherals

modem. If it cannot find a string that automatically initializes the Practical Peripherals modems, you must initialize them manually, as specified in the following section, "Initializing the Practical Peripherals Modems."

In this example, the access server is configured to allow dial-in clients to launch ARA, PPP, or an EXEC session on lines 1 through 16.

```
version 11.2
!
hostname 2511
!
line 1 16
 modem autoconfigure type hayes_optima
 speed 115200
 flowcontrol hardware
 modem inout
 transport input all
 autoselect arap
 autoselect during-login
 autoselect ppp
 arap enabled
!
line con 0
 speed 9600
 flowcontrol software
```

Initializing the Practical Peripherals Modems

The following steps show how to initialize a Practical Peripherals modem to function with a Cisco 2509 access server.

Step 1 Connect with the modem, which is attached to asynchronous port 4. The IP address of the Ethernet interface is 172.18.2.24:

```
2509# telnet 172.18.2.24 2004
Trying 172.16.1.10, 2001 ... Open
```

Step 2 Issue an **at** command to ensure the modem connection has been established:

```
at
ok
```

Step 3 Configure the modem initialization string (the following is the string for a Practical Peripherals 28.8 modem):

```
AT&F&C1&D3&K3&Q5S7=60S36=7S46=2S48=7S95=47S0=1&W
ok
```

Step 4 Store the modem settings in the modem NVRAM:

```
at&w
OK
```

Step 5 Suspend and disconnect your Telnet session:

```
- suspend keystroke -
2509# disconnect
Closing connection to 172.18.2.24, 2004 [confirm] y
2509#
```

Security Configuration

This sample configuration uses a RADIUS security server for asynchronous interfaces and local authentication for lines, because ARA, which is configured on lines, does not support RADIUS authentication. The login authentication in this configuration works as follows:

- Users dialing in to the EXEC facility are first authenticated by a RADIUS server. If a RADIUS server is not accessible, local authentication is used.
- Users dialing in with ARA are allowed to log in as guests only if they have already been authenticated to the EXEC facility.
- Users dialing in with PPP are authenticated only if they have not already been authenticated at the EXEC facility. If they have not already been authenticated, the RADIUS server is polled. If the RADIUS server has no information about the user or it is not accessible, local username authentication is used. Users dialing in to group async interface 0 are authenticated using CHAP. Users dialing in to group async interface 1 are authenticated using PAP.

This sample configuration only contains security commands. It does not contain modem or protocol configuration commands. For modem and line commands, refer to the "Modem and Line Configuration" section. For protocol configuration commands, refer to the "Protocol Configuration" section.

```
aaa new-model
aaa authentication login default radius local
aaa authentication arap default auth-guest local
aaa authentication ppp default if-needed radius
!
radius-server host 172.23.4.28
radius-server key s2imm3r
!
username pumba password 7 095E470B1110
username timone password 7 095E470B1110
username rafiki password 7 0215055500070C294D
username simba password 7 032A5K39068R1935
username nala password 7 087X2G10385V8148
username mufasa password 7 075V3W50429L2943
username sarabi password 7 0215055500070C294D

enable secret 5 $1$Kv7T$yjdYBYi70X56gOpEtLj.Q.!
!
line 1 16
 arap authentication default
!
line con 0
 login authentication default
!
interface Group-Async1
 ppp authentication chap default
 group range 1 8
!
interface Group-Async2
 ppp authentication pap default
 group range 9 16
```

Protocol Configuration

The following sample configuration enables remote clients to dial in and access IP, IPX, and AppleTalk resources. In this example, IP and IPX client connections are permitted on group asynchronous interface 1 to IP, IPX, and AppleTalk resources. The IPX network number of loopback interface 1 is assigned to the group asynchronous interface. Routing updates have been filtered on all asynchronous interfaces.

ARA has also been enabled on all lines. Macintosh clients can also dial in and access IP network resources.

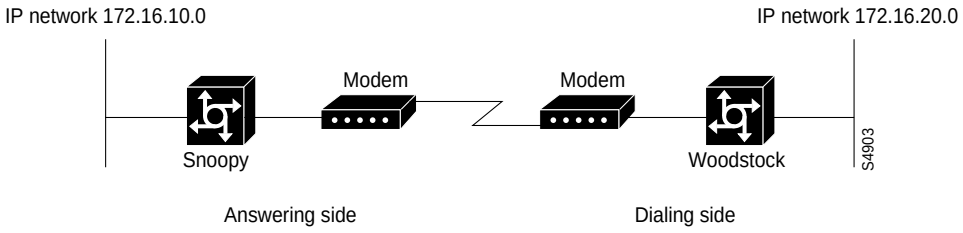
```
ip domain-name cisco.com
ip name-server scar
ipx routing 0040.0d05.c601
ip address-pool local
!
appletalk routing
appletalk virtual-net 2000 Mac-dialup
arap network 2500 Mac-dialup
!
async dns-server 172.16.80.34
async nbns-server 172.16.80.35
!
interface loopback0
 no ip address
 ipx network 544
 ipx sap-interval 0
!
interface ethernet0
 ip address 172.21.14.64 255.255.255.0
 appletalk cable-range 110-110
 appletalk zone corporate
 ip tcp header-compression passive
 ipx network AC150E00
 ipx encapsulation SAP
!
interface group-async1
 ip unnumbered ethernet0
 encapsulation ppp
 async mode interactive
 appletalk client-mode
 peer default ip address pool singi
 ipx ppp-client loopback0
 netbios nbf
 group-range 1 8
!
interface group-async2
 ip unnumbered ethernet0
 encapsulation ppp
 async mode interactive
 peer default ip address pool bonsai
 ipx ppp-client loopback0
 group-range 9 16
!
ip local pool singi 172.16.80.1 172.16.80.16
ip local pool bonsai 172.16.80.17 172.16.80.32
!
ipx router rip
 no network 544
!
line 1 16
 arap enable
 autoselect arap
 autoselect during-login
 autoselect ppp
 arap timelimit 240
 arap warningtime 15

! the following commands enable Macintosh clients to access IP network resources
appletalk macip server 172.21.14.64 zone corporate
appletalk macip dynamic 172.21.14.65 172.21.14.81 zone corporate
```

Routing across Modem Lines

Previous chapters in this guide have focused on configuring an access server to allow remote node computers to dial in to a network. This chapter describes how to configure two access servers so that one places an outgoing call and a second access server accepts. The access server initiating the call establishes a dial-on-demand routing (DDR) connection to the answering access server when packets that are considered "interesting" (IP unicast packets) pass through the interface configured to initiate a call.

Figure 6-1 shows a simple DDR scenario between two access servers. In this example, an IP host on network 172.16.20.0 opens a connection session with a host on IP network 172.16.10.0. The two access servers exchange routing information using the RIP routing protocol (although RIP broadcasts cannot initiate a call or keep the line active). This figure is referred to throughout this chapter and the sample configurations are based on this figure.

Figure 6-1 Asynchronous Dial-on-Demand Routing Network Design



In the preceding example, the answering access server is Snoopy on IP network 172.16.10.0, and the dialing access server is Woodstock on IP network 172.16.20.0. You must configure the answering access server first, then configure the dialing access server.

Configuring the Answering Access Server

In this configuration, the answering access server has the name Snoopy. This name is passed by this access server in a PPP authentication process. Each access server has the name of the other access server defined in its username database (with the **username** command). That is, the dialing access server—Woodstock—must have a username Snoopy defined, and the answering access server—Snoopy—must have the username Woodstock defined. Refer to the section "Configuring Security for the Access Server Answering the DDR Call."

Note Names are case sensitive, so be sure that both the dialing and answering access servers use the same capitalization and spelling.

Perform the steps in the following procedures to configure the answering access server (Snoopy). The configuration is broken into procedural components (routing in global configuration mode, the Ethernet interface, asynchronous interfaces, security, and so on).

Defining Modem Parameters

Perform the following steps to configure modem support for an access server answering DDR calls (Snoopy):

Step 1 Configure the line speed. In the following example, line speed is set to 115200 bps. If you are configuring dialin on an AUX port, the maximum speed is 38400 bps.

```
Snoopy(config)# line tty 1
Snoopy(config-line)# speed 115200
```

Step 2 Configure flow control on the line accepting the incoming DDR call.

```
Snoopy(config-line)# flowcontrol hardware
```

Step 3 Because the answering access server is taking incoming calls on line 1 only, configure the modem to accept incoming calls on that line.

```
Snoopy(config-line)# modem dialin
```

Note You cannot establish a reverse Telnet session to the modem attached to line 1 if the **modem dialin** command is used. To use reverse Telnet, you must use the **modem inout** command. After a reverse Telnet session is completed, you can reissue the **modem dialin** command.

Configuring Routing and a Routing Protocol

Perform the following steps to configure RIP routing on the access server answering DDR calls (Snoopy).

Step 1 Configure RIP routing globally on the access server answering DDR calls (Snoopy):

```
Snoopy(config)# router rip
Snoopy(config-router)#
```

Step 2 Associate a network to the RIP routing process:

```
Snoopy(config-router)# network 172.16.0.0
Snoopy(config-router)# exit
Snoopy(config)#
```

Step 3 Create a static default route. A static default route is required because routes that are resolved dynamically are lost when the DDR link is down. If the access server receives a packet that is destined to a network not listed in its routing table, the access server forwards this packet to the access server on the other side of the dialup link (in this case to 172.16.20.1), which is the address of the opposite access server (Woodstock).

```
Snoopy(config)# ip route 0.0.0.0 0.0.0.0 172.16.20.1
```

Step 4 Configure a second static route, because the asynchronous interface is unnumbered (refer to the section "Configuring the Asynchronous Interface Answering the DDR Call"). A second static route is needed to tell the local access server (Snoopy) which interface to use to get to the device at address 172.16.20.1. A mask of 255.255.255.255 is used to specify that this route is a host address.

```
Snoopy(config)# ip route 172.16.20.1 255.255.255.255 async1
```

Configuring Ethernet Interface 0

Perform the following task to configure Ethernet interface 0 on the access server answering incoming DDR calls (Snoopy):

Assign an IP address to Ethernet interface 0:

```
Snoopy(config-router)# interface Ethernet0
Snoopy(config-if)# ip address 172.16.10.1 255.255.255.0
```

Configuring the Asynchronous Interface Answering the DDR Call

Perform the following steps to configure the asynchronous interface answering DDR calls (Snoopy):

Step 1 Configure the asynchronous interface through which you need to accept a call as IP unnumbered to conserve IP addresses and assign the IP address for Ethernet interface 0 to it.

```
Snoopy(config-if)# interface Async1
Snoopy(config-if)# ip unnumbered Ethernet0
```

Step 2 Encapsulate PPP on the interface.

```
Snoopy(config-if)# encapsulation ppp
```

Step 3 Specify asynchronous dynamic routing on the interface. The **async dynamic routing** command allows routing protocols to be run over the asynchronous interface to resolve IP routes dynamically. If the command is omitted, static routes can still be used.

```
Snoopy(config-if)# async dynamic routing
```

Step 4 Specify the IP address of the opposite access server's (Woodstock's) Ethernet 0 interface as the default IP address:

```
Snoopy(config-if)# peer default ip address 172.16.20.1
```

Step 5 Configure the asynchronous interface as dedicated to PPP mode, which means that the access server automatically uses a PPP session for this interface, and that the user will not see an EXEC prompt. The **async mode dedicated** command enables the configured session type to start automatically when the DDR link comes up.

```
Snoopy(config-if)# async mode dedicated
```

Step 6 (Optional) Configure DDR support on the asynchronous interface using the **dialer in-band** command.

```
Snoopy(config-if)# dialer in-band
```

Step 7 Set the number of seconds the connection remains open if no interesting traffic is being routed across this link. The timer is reset each time an interesting packet is forwarded across the DDR connection. You need to set the idle-timeout to the same value on both access servers. In this example, the line is closed after 5 consecutive minutes without interesting traffic.

```
Snoopy(config-if)# dialer idle-timeout 300
```

Step 8 Specify that the name Woodstock be used to authenticate the dialin user. If authentication is successful, the IP address of the dialing access server's Ethernet interface (in this case, 172.16.20.1) is mapped to the remote user. Also, enable broadcast packets to be forwarded to this address (such as RIP or IGRP updates for IP).

Note There is no telephone number specified in the **dialer map** command, because Snoopy is not calling out. Snoopy is only accepting incoming DDR calls.

```
Snoopy(config-if)# dialer map ip 172.16.20.1 name Woodstock broadcast
```

Step 9 Associate this interface with the dialer list 1 definition by using the **dialer-group 1** command. The interface now considers anything defined in dialer list 1 as interesting traffic.

```
Snoopy(config-if)# dialer-group 1
Snoopy(config-if)# exit
```

Configuring Security for the Access Server Answering the DDR Call

To configure security on an access server answering DDR calls (Snoopy), perform these steps:

Step 1 Specify the name of the dialing access server (Woodstock) in Snoopy's username database. This username is referenced in the **dialer map** command for authentication purposes. The username is case sensitive and must match the opposite access server's host name exactly. The password (peanuts) is used as the PPP authentication password for the user Woodstock. It is also case sensitive:

```
Snoopy(config)# username Woodstock password peanuts
```

Note If you enter the password **peanuts**, exit to privileged EXEC mode, and issue the **show running-config** command, the output of this command displays an encrypted password, similar to the following: `username Woodstock password 7 0215055500070C294D`. When you enter or make changes to the username command, always enter the password in its unencrypted form. Do not enter the encryption type (7). It is set automatically.

Step 2 Create a PPP authentication list and a login authentication list:

```
Snoopy(config)# aaa authentication ppp default local
Snoopy(config)# aaa authentication login default local
```

Step 3 Apply the PPP authentication list to the asynchronous interface answering DDR calls and specify CHAP authentication (rather than PAP):

```
Snoopy(config)# interface async 1
Snoopy(config-if)# ppp authentication chap default
```

Step 4 Require login authentication on VTY lines 0 through 4. The login authentication default command uses the **aaa authentication default local** authentication list. The local keyword means that the local username database will be used for security. On this access server, only five VTY lines have been defined.

```
Snoopy(config-if)# line vty 0 4
Snoopy(config-line)# login authentication default
```

Step 5 Create access list filters. In this example, the packets that the access list permits are referenced by the **dialer-list** command (in Step 6 of this procedure) to determine interesting packets.

```
Snoopy(config-line)# exit
Snoopy(config)# access-list 100 deny ip 0.0.0.0 255.255.255.255 255.255.255.255
                0.0.0.0
Snoopy(config)# access-list 100 permit ip 0.0.0.0 255.255.255.255 0.0.0.0
                255.255.255.255
```

In the preceding **access-list** command, the number 100 is the list identifier. All access-list commands with the same identifier define a single filter. Ordering of the access-list commands is very important. Statements in an access list are parsed one by one until a match is found. After a match is found, any access list definitions that follow are ignored. Although it is not displayed, an implicit "deny all" statement is always appended to the end of an access list. Therefore, if a packet reaches the end of an access list without matching a permit statement, the packet is denied automatically.

The line **access-list 100 deny ip 0.0.0.0 255.255.255.255 255.255.255.255 0.0.0.0** specifies that all broadcast packets are uninteresting. Specifically, RIP updates cannot initiate a call, nor can they reset the dialer idle-timeout counter in this example.

The line **access-list 100 permit ip 0.0.0.0 255.255.255.255 0.0.0.0 255.255.255.255** specifies that all other IP packets are interesting.

Step 6 Reference the filter defined by access list 100. Packets permitted by access list 100 are considered interesting packets for a DDR interface belonging to dialer group 1.

```
Snoopy(config)# dialer-list 1 list 100
```

You have configured the answering access server (Snoopy). At this point, you can configure the dialing access server (Woodstock).

Configuring the Dialing Access Server

In this configuration, the dialing access server has the name Woodstock. This name is passed by this access server during the PPP authentication process, in the same way that the answering access server's name is authenticated. (Refer to the section "Configuring Security for the Dialing Access Server.")

Note Names are case sensitive, so be sure that both the dialing and answering access servers use the same capitalization and spelling.

Perform the steps in the following procedures to configure the access server that initiates the call (Woodstock). The configuration is broken into components (routing in global configuration mode, the Ethernet interface, asynchronous interfaces, security, and so on).

Defining Modem Parameters on the Dialing Access Server

Perform the following steps to configure modem support for an access server initiating DDR calls (Woodstock):

Step 1 Configure the line speed. In the following example, line speed is set to 115200 bps. If you are configuring dialout on an AUX port, the maximum speed is 38400 bps.

```
Woodstock(config)# line tty 1
Woodstock(config-line)# speed 115200
```

Step 2 Configure flow control on the line making the outgoing DDR call.

```
Woodstock(config-line)# flowcontrol hardware
```

Step 3 Because the access server is making outgoing calls on line 1 only, configure the modem to make outgoing calls on that line.

```
Woodstock(config-line)# modem inout
```

Step 4 Define a chat script to send commands to the modem (note that chat scripts are case sensitive).

```
Woodstock(config)# chat-script dialnum "" "atdt\T" TIMEOUT 60 CONNECT \c
```

This script, named dialnum, sends the `atdt` string to the modem. The `\T` in the script specifies that the phone number that appears in the **dialer map** statement be sent (see Step 8 in the section "Configuring the Asynchronous Interface Dialing the DDR Call").

Step 5 Create a chat script to initialize the modem making the DDR call. In this case, the name of the chat script is rstusr. When this script is executed, the modem string `at&fs0=1e0&r2&d2&c1&b1&h1&m0&k0` is sent.

```
Woodstock(config)# chat-script rstusr "" "at&fs0=1e0&r2&d2&c1&b1&h1&m0&k0" "OK"
```

Other modems require similar settings, but different syntax. In this example, this script is executed by the **script reset rstusr** command, as shown in the following step.

Step 6 Assign the chat script rstusr to the asynchronous line.

```
Woodstock(config)# line tty 1
Woodstock(config-line)# script reset rstusr
```

The **reset** string causes the chat script **rstusr** to be sent to the modem when the line is reset.

Step 7 Enable pulsing DTR signal intervals on the asynchronous interface to ensure that the modem properly disconnects by using the **pulse-time** command. This command is needed on the dialing access server only.

```
Woodstock(config-line)# interface async 1
Woodstock(config-if)# pulse-time 3
```

Configuring Routing and a Routing Protocol on the Dialing Access Server

Perform the following steps to configure RIP routing on the access server initiating DDR calls (Woodstock):

Step 1 Configure RIP routing globally on the access server:

```
Woodstock(config)# router rip
Woodstock(config-router)#
```

Step 2 Associate a network to the RIP routing process:

```
Woodstock(config-router)# network 172.16.0.0
Woodstock(config-router)# exit
Woodstock(config)#
```

Step 3 Create a static default route. A static default route points to the answering access server's IP network number (in this case 172.16.10.0) via the next hop (in this case 172.16.10.1). Static default routes are required because dynamic routes are lost when the link is down.

```
Woodstock(config)# ip route 172.16.10.0 255.255.255.0 172.16.10.1
```

Step 4 Configure a second default route, because the asynchronous interface is unnumbered (refer to the section "Configuring the Asynchronous Interface Dialing the DDR Call"). A second static route is needed to tell the local access server (Woodstock) how to get to the device at address 172.16.10.1. A mask of 255.255.255.255 is used to specify that this route is a host address.

```
Woodstock(config)# ip route 172.16.10.1 255.255.255.255 async1
```

Configuring the Ethernet Interface 0 for the Dialing Access Server

Perform the following task to configure the Ethernet interface 0 on the access server initiating outgoing DDR calls (Woodstock):

Assign an IP address to the Ethernet interface 0:

```
Snoopy(config-router)# interface Ethernet0
Snoopy(config-if)# ip address 172.16.20.1 255.255.255.0
```

Configuring the Asynchronous Interface Dialing the DDR Call

Perform the following steps to configure the asynchronous interface initiating DDR calls:

Step 1 Configure the asynchronous interface through which you need to place calls as IP unnumbered to conserve IP addresses and assign the IP address for Ethernet interface 0 to it.

```
Woodstock(config-if)# interface async1
Woodstock(config-if)# ip unnumbered Ethernet0
```

Step 2 Encapsulate PPP on the interface.

```
Woodstock(config-if)# encapsulation ppp
```

Step 3 Specify asynchronous dynamic routing on the interface. The **async dynamic routing** command allows routing protocols to be run over the asynchronous interface to resolve IP routes dynamically. If the command is omitted, static routes can still be used.

```
Woodstock(config-if)# async dynamic routing
```

Step 4 Specify the IP address of opposite access server's (Snoopy's) Ethernet interface 0 as a default IP address:

```
Woodstock(config-if)# peer default ip address 172.16.10.1
```

Step 5 Configure the asynchronous interface as dedicated to PPP mode, which means that the access server automatically uses a PPP session for this interface. The **async mode dedicated** command enables the configured session type to start automatically when the DDR link comes up.

```
Woodstock(config-if)# async mode dedicated
```

Step 6 Configure DDR support on the asynchronous interface using the **dialer in-band** command.

```
Woodstock(config-if)# dialer in-band
```

Step 7 Set the number of seconds the connection remains open if no interesting traffic is being routed across this link. The timer is reset each time an interesting packet is forwarded across the DDR connection. You need to set the idle-timeout to the same value on both access servers. In this example, the line is closed after 5 consecutive minutes without interesting traffic.

```
Woodstock(config-if)# dialer idle-timeout 300
```

Step 8 Issue the **dialer map** command. In addition to authentication on the dialing access server, this command also provides the dial string and the modem script that are used to dial the number. The command essentially maps a name, modem script, and phone number to a destination IP address.

```
Woodstock(config-if)# dialer map ip 172.16.10.1 name Snoopy modem-script dialnum
                      broadcast 14085554321
```

The address 172.16.10.1 is the IP address of the answering access server's asynchronous interface. Because IP unnumbered interfaces are being used, this address is the same as the central IP address assigned to the Ethernet interface 0.

The name Snoopy is the host name of the remote access server. The name is case sensitive and must be defined as a username.

The modem-script dialnum specifies that this chat-script (**dialnum**) be sent when the access server initiates a call.

The keyword **broadcast** enables broadcast packets to be forwarded to this address (such as RIP or IGRP updates for IP and RIP and SAP updates for IPX).

The number 14085554321 is the answering access server's telephone number. This is the number to dial to reach the remote access server.

Step 9 Associate this asynchronous interface with the dialer list 1 definition by using the **dialer-group 1** command. The interface now considers anything defined in dialer list 1 as interesting traffic.

```
Woodstock(config-if)# dialer-group 1
```

Configuring Security for the Dialing Access Server

Perform the following steps to configure security on an access server initiating DDR calls (Woodstock):

Step 1 Specify the name of the access server answering a call (Snoopy) in Woodstock's username database. This username is referenced in the **dialer map** command for authentication purposes. The username is case sensitive and must match the opposite access server's host name exactly. The password (peanuts) is used as the PPP authentication password for the user Snoopy. It is also case sensitive:

```
Woodstock(config)# username Snoopy password peanuts
```

Note If you enter the password peanuts, exit to privileged EXEC mode, and issue the **show running-config** command, the output of this command shows up with an encrypted password, similar to the following: `username Snoopy password 7 0215055500070C294D`. When you enter or make changes to the **username** command, always enter the password in its unencrypted form. Do not enter the encryption type (7). It is set automatically.

Step 2 Create a PPP authentication list:

```
Woodstock(config)# aaa authentication ppp default local
Woodstock(config)# aaa authentication login default local
```

Step 3 Apply the PPP authentication list to the asynchronous interface initiating DDR calls and specify CHAP authentication (rather than PAP):

```
Woodstock(config)# interface async 1
Woodstock(config-if)# ppp authentication chap default
```

Step 4 Require login authentication on VTY lines 0 through 4. The **login authentication default** command uses the **aaa authentication default local** authentication list. The **local** keyword means that the local username database is used for security. On this access server, only five VTY lines have been defined.

```
Snoopy(config-if)# line vty 0 4
Snoopy(config-line)# login authentication default
```

Step 5 Apply login authentication to TTY lines 1 to 16 on the access server.

```
Woodstock(config-if)# line 1 16
Woodstock(config-line)# login authentication default
```

Step 6 Create access list filters. In this example, the packets that the access list permits are referenced by the **dialer-list** command (in Step 7 in this procedure) to determine interesting packets and activate a call. The access list you create depends on your particular network design.

```
Woodstock(config-line)# exit
Woodstock(config)# access-list 100 deny ip 0.0.0.0 255.255.255.255 255.255.255.255
                   0.0.0.0
Woodstock(config)# access-list 100 permit ip 0.0.0.0 255.255.255.255 0.0.0.0
                    255.255.255.255
```

The line **access-list 100 deny ip 0.0.0.0 255.255.255.255 255.255.255.255 0.0.0.0** specifies that all broadcast packets are uninteresting.

The line **access-list 100 permit ip 0.0.0.0 255.255.255.255 0.0.0.0 255.255.255.255** specifies that all other IP packets are interesting.

Step 7 Reference the filter defined by access list 100. Packets permitted by access list 100 are considered interesting packets for a DDR interface belonging to dialer group 1.

```
Woodstock(config)# dialer-list 1 list 100
```

The **dialer-list** command points to the list of commands that belong to access list 100. Packets defined by access list 100 are interesting packets for any interface belonging to dialer-group 1. The **dialer-list** command is similar to the **dialer-list 1 protocol ip permit** command on the answering access server. However, the **dialer-list 1 list 100** command does not allow broadcast packets to keep the line up.

Step 8 Specify a password (test in this example) on VTY lines 0 through 4. On this access server, only five VTY lines have been defined.

```
Woodstock(config-if)# line vty 0 4
Woodstock(config-line)# password test
```

Step 9 Enable login to VTY lines 0 through 4:

```
Woodstock(config-line)# login
```

You have configured the dialing access server. To ensure the dial-on-demand function works, perform a task that requires your dialing access server to place a call to your answering access server.

Sample Configurations for Routing Across Modem Lines

This section shows sample output for access servers set up for unnumbered IP dial-on-demand routing on an asynchronous interface. These sample configurations are based on the steps you followed in the preceding sections of this chapter to configure the answering and dialing access servers.

Sample Configuration for the Answering Access Server

The following sample configuration is for the answering access server (Snoopy):

```
Current configuration:
!
version 12.0
!
hostname Snoopy
!
enable password test
!
aaa authentication ppp default local
!
username Woodstock password 7 kd345096ix09ghu934c=e
!
interface Ethernet0
 ip address 172.16.10.1 255.255.255.0
!
interface Serial0
 no ip address
 shutdown
!
interface Serial1
 no ip address
 shutdown
!
interface Async1
 ip unnumbered Ethernet0
 encapsulation ppp
```

```
 peer default ip address 172.16.20.1
 async dynamic routing
 async mode dedicated
 dialer idle-timeout 300
 dialer map ip 172.16.20.1 name Woodstock broadcast
 ppp authentication chap
 dialer-group 1
!
router rip
 network 172.16.0.0
!
access-list 100 deny ip 0.0.0.0 255.255.255.255 255.255.255.255 0.0.0.0
access-list 100 permit ip 0.0.0.0 255.255.255.255 0.0.0.0 255.255.255.255
!
dialer-list 1 list 100
!
ip route 0.0.0.0 0.0.0.0 172.16.20.1
ip route 172.16.20.1 255.255.255.255 async1
!
line con 0
line aux 0
 modem dialin
 speed 115200
 flowcontrol hardware
line vty 0 4
 password cisco
!
end
```

Sample Configuration for the Dialing Access Server

The following sample configuration is for the dialing access server (Woodstock):

```
Current configuration:
!
version 12.0
!
hostname Woodstock
!
enable password test
!
username Snoopy password peanuts
chat-script dialnum "" "atdt\T" TIMEOUT 60 CONNECT \c
chat-script rstusr "" "at&fs0=1e0&r2&d2&c1&b1&h1&m0&k0" "OK"
!
interface Ethernet0
 ip address 172.16.20.1 255.255.255.0
!
interface Serial0
 no ip address
!
interface Serial1
 no ip address
!
interface Async1
 ip unnumbered Ethernet0
 encapsulation ppp
 async default ip address 172.16.10.1
 async dynamic routing
 async mode dedicated
 dialer in-band
 dialer idle-timeout 300
 dialer map ip 172.16.10.1 name Snoopy modem-script dialnum broadcast 14085554321
 dialer-group 1
```

```
 ppp authentication chap
 pulse-time 3
!
router rip
 network 172.16.0.0
!
ip route 0.0.0.0 0.0.0.0 172.16.10.1
ip route 172.16.10.1 255.255.255.255 async 1
!
access-list 100 deny ip 0.0.0.0 255.255.255.255 255.255.255.255 0.0.0.0
access-list 100 permit ip 0.0.0.0 255.255.255.255 0.0.0.0 255.255.255.255
!
dialer-list 1 list 100
!
line con 0
line aux 0
 modem InOut
 speed 115200
 script reset rstusr
 flowcontrol hardware
!
line vty 0 4
 password test
 login
!
end
```

Security Configuration

The access service security paradigm presented in this guide uses the authentication, authorization, and accounting (AAA) facility. Authentication requires dial-in users to prove they are who they say they are. When you require authentication before users can access your network, you are preventing users from either accessing lines on the access server or connecting through the lines directly to network resources. You need to secure every access point.

Authorization prevents each user from gaining access to services and devices on the network that they do not need to or are not supposed to access. Accounting provides records of who is connected and how long they have been connected for billing and other recording purposes. This chapter does not describe how to configure accounting.

This chapter describes how to configure security using a local database resident on the access server or using a remote security database for TACACS+ and RADIUS. To understand the concept of local versus remote authentication, refer to the section "Local Versus Remote Server Authentication" later in this chapter.

Caution This chapter does not provide an exhaustive security overview. For example, it does not describe how to configure TACACS, Extended TACACS, Kerberos, or access lists. It presents the most commonly used security mechanisms to prevent unauthenticated and unauthorized access to network resources through Cisco access servers. For a comprehensive overview of Cisco security mechanisms, refer to the *Security Configuration Guide*.

Specifically, this chapter describes the following:

- Local Versus Remote Server Authentication
- Configuring Authentication
- Configuring Authorization
- Security Configuration Examples

Assumptions

This chapter assumes the following:

- You know which network protocols you will allow access to your network. For example, you know if you will be allowing clients to dial in using modems to access IP, IPX, or AppleTalk networks, or whether clients will be using ISDN to access any of these networks.
- You are not an advanced user of the Cisco AAA security facility.

Local Versus Remote Server Authentication

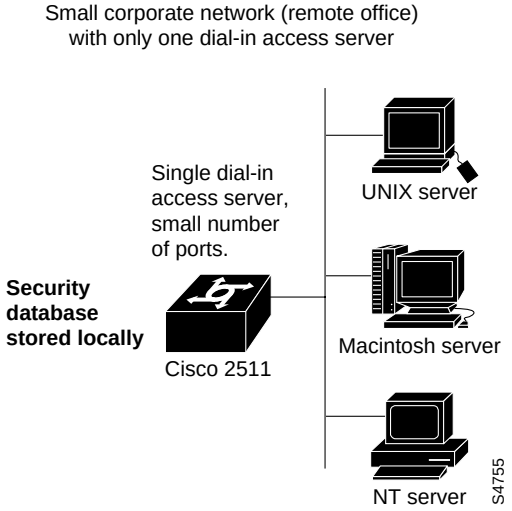
This section describes the differences between local and remote security databases and the basic authentication process for each. Remote security databases described in this chapter include Terminal Access Controller Access Control System with Cisco proprietary enhancements (TACACS+) and Remote Authentication Dial-In User Service (RADIUS).

Generally the size of the network and type of corporate security policies and control determines whether you use a local or remote security database.

Local Security Database

If you have one or two access servers providing access to your network, you probably want to store username and password security information on the Cisco access server. This is referred to as local authentication. (See Figure 7-1.)

Figure 7-1 Local Security Database



A local security database is useful if you have very few access servers providing network access. A local security database does not require a separate (and costly) security server.

Remote Security Database

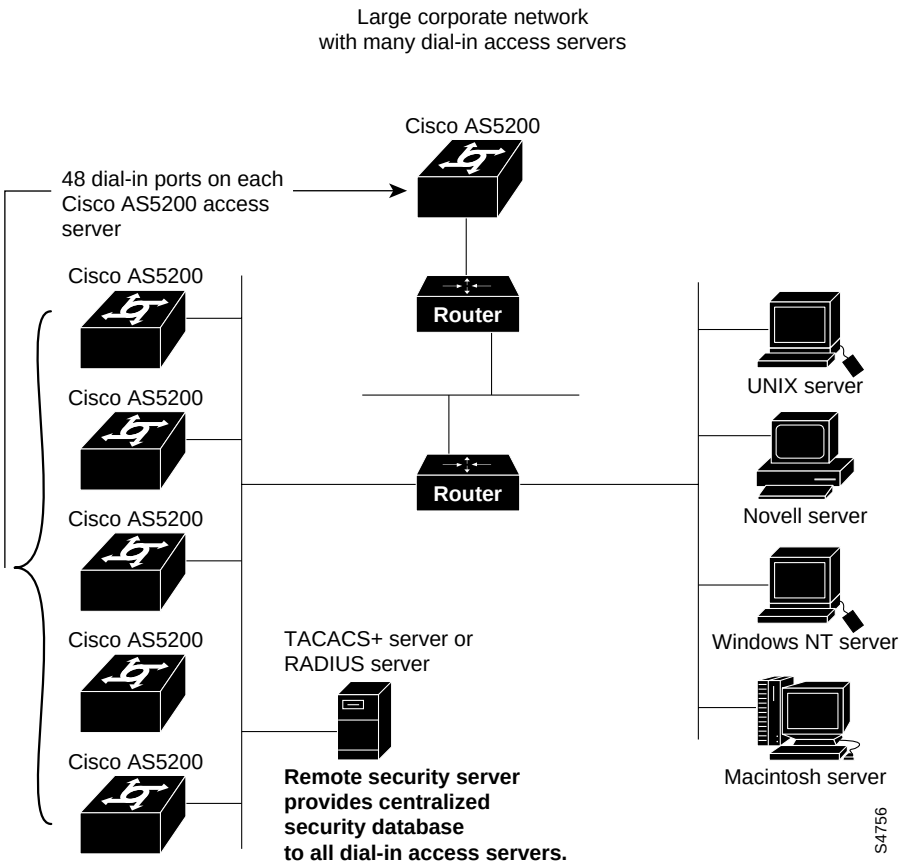
As your network grows, you need a centralized security database that provides username and password information to each of the access servers on the network. This centralized security database resides in a security server. (See Figure 7-2.)

An example of a remote security database server is the CiscoSecure product from Cisco Systems, Inc. CiscoSecure is a UNIX security daemon solution, with which the administrator creates a database that defines the network users and their privileges. CiscoSecure uses a central database that stores user and group profiles with authentication and authorization information.

The Cisco access server exchanges user authentication information with a TACACS+ or RADIUS database on the security server by transmitting encrypted TACACS+ or RADIUS packets across the network.

For specific information about the interaction between the security server and the access server, refer to the *Security Configuration Guide*.

Figure 7-2 Remote Security Database



A remote, centralized security database is useful when you have a large number of access servers providing network access. It prevents having to update each access server with new or changed authentication and authorization information for potentially hundreds of thousands of dial-in network users. A centralized security database also helps establish consistent remote access policies throughout a corporation.

Configuring Authentication

Using the AAA facility, you can authenticate users with either a local or a remote security database. For more information about what a local and remote security database are, refer to the previous section “Local Versus Remote Server Authentication.”

Whether you maintain a local or remote security database, or use TACACS+ or RADIUS authentication and authorization, the process of configuring the access server for these different databases and protocols is similar. The basic process of configuring the Cisco IOS software for authentication requires the following tasks:

1. Securing Access to Privileged EXEC and Configuration Mode
2. Enabling Communication between the Access Server and the Security Server

3 Enabling AAA Globally on the Access Server

4 Defining Authentication Method Lists

- 1. Issue the aaa authentication Command
- 2. Specify Protocol or Login Authentication
- 3. Identify a List Name
- 4. Specify the Authentication Method

5 Applying Authentication Method Lists to Lines and Interfaces

- Apply login lists to VTY lines and the console port
- Apply authentication lists to asynchronous or ISDN *interfaces* configured for PPP
- Apply authentication lists asynchronous (TTY) *lines* configured for ARA

Securing Access to Privileged EXEC and Configuration Mode

The first thing you secure is access to privileged EXEC (enable) mode. Enable mode provides access to configuration mode, which enables any type of configuration change to the access server. To secure privileged EXEC mode, use one of the commands listed in Table 7-1:

Table 7-1 Commands Used to Secure Access to Privileged EXEC Mode

Command	Purpose
enable password *password*	Requires that network administrators enter a password to access privileged EXEC mode. Do not provide access to non administrators.
enable secret *password*	Specifies a secret password that is encrypted, so that the password cannot be read when crossing a network. After you issue this command, the encryption cannot be reversed. The encrypted version of the password appears in output of the **show running-config** and **show startup-config** commands. The enable secret password has precedence over the enable password. Do not enter the same password as the enable password. If the two passwords are the same, the enable secret password is not a secret, because the enable password appears in output of **show running-config** and **show startup-config** commands.

For more information about the enable password and enable secret commands and their complete syntax, refer to the *Security Command Reference*.

Caution If you use the **enable secret** command and specify an encryption type, you *must* enter the *encrypted version* of a specific password. Do not enter the cleartext version of the password after specifying an encryption type. You must comply with the following procedure when you specify an encryption type or you will be locked irretrievably out of privileged EXEC (enable) mode. The only way to regain access to privileged EXEC mode will be to erase the contents of NVRAM, erase your entire configuration, and reconfigure the router again.

To enter an encryption type with the **enable secret** command, perform the following steps:

Step 1 From within global configuration mode, enter the **enable secret** command, followed by the cleartext password that you will use to gain access to privileged EXEC mode. Do not specify an encryption type.

Step 2 Exit from global configuration mode and enter the command **show running-config** to view the encrypted version of the password. The following example illustrates these first two steps:

```
2511(config)# enable secret mypassword
2511(config)# exit
2511# show running-config
Building configuration...

Current configuration:
!
version 12.0
! some of the configuration skipped
enable secret 5 $1$h7dd$VTNs4.BAfQMUU0Lrvw6570
! the rest of the configuration skipped
```

Step 3 At this point, select and copy the encrypted password following `enable secret 5` in the configuration output (`$1$h7dd$VTNs4.BAfQMUU0Lrvw6570`).

Step 4 Enter global configuration mode and enter the **enable secret** command, followed by the encryption type (5 is the only valid encryption type for **enable secret**), then paste in the encrypted version of the password, as shown in the following example:

```
2511(config)# enable secret 5 $1$h7dd$VTNs4.BAfQMUU0Lrvw6570
```

Step 5 Exit from global configuration mode and copy the running configuration to NVRAM.

```
2511(config)# exit
2511# copy running-config startup-config
```

You can also specify additional protection for privileged EXEC mode, including the following:

- Privilege levels for Cisco IOS commands
- Privileged EXEC passwords for different privilege levels
- Privilege levels for specific lines on the access server
- Encrypt passwords using **service password-encryption**

For more information about these security tools, refer to the *Security Configuration Guide* in the Cisco IOS configuration guides and command references documentation.

Enabling Communication between the Access Server and the Security Server

This section describes the Cisco IOS software commands that enable the access server to communicate with a security server. This process is similar for communicating with TACACS+ and RADIUS servers, and the following sections describe the process.

If you are using local authentication, you can refer to the section “Enabling AAA Globally on the Access Server.”

If you are using a remote security server for authentication and authorization, you must configure the security server before performing the tasks described in this chapter. The section “Security Configuration Examples” at the end of this chapter shows some typical TACACS+ and RADIUS server entries corresponding to the access server security configurations.

Communicating with a TACACS+ Server

To enable communication between the TACACS+ security (database) server and the access server, issue the commands listed in Table 7-2 in global configuration mode.

Table 7-2 Commands for Communicating with a TACACS+ Server

Command	Purpose
tacacs-server host {*hostname* | *ip-address*}	Specifies the IP address or the host name of the remote TACACS+ server host. This host is typically a UNIX system running TACACS+ software.
tacacs-server key *shared-secret-text-string*	Specifies a shared secret text string used between the access server and the TACACS+ server. The access server and TACACS+ server use this text string to encrypt passwords and exchange responses.

For example, to enable the remote TACACS+ server to communicate with the access server, enter the commands as follows:

```
2511# configure terminal
2511(config)# tacacs-server host alcatraz
2511(config)# tacacs-server key abra2cad
```

The host name of the TACACS+ server in the previous example is alcatraz. The key (**abra2cad**) in the previous example is the encryption key shared between the TACACS+ server and the access server.

For more information about these commands, refer to the *Security Command Reference*, which is part of the Cisco IOS configuration guides and command references documentation.

Communicating with a RADIUS Server

To enable communication between the RADIUS security (database) server and the access server, issue the commands listed in Table 7-3 in global configuration mode.

Table 7-3 RADIUS Server Commands

Command	Purpose
radius-server host {*hostname* | *ip-address*}	Specifies the IP address or the host name of the remote RADIUS server host. This host is normally a UNIX system running RADIUS software.
radius-server key *shared-secret-text-string*	Specifies a shared secret text string used between the router and the RADIUS server. The router and RADIUS server use this text string to encrypt passwords and exchange responses.

For example, to enable the remote RADIUS server to communicate with the access server, enter the commands as follows:

```
2511# configure terminal
2511(config)# radius-server host alcatraz
2511(config)# radius-server key abra2cad
```

The host name of the RADIUS server in the previous example is alcatraz. The key (**abra2cad**) in the previous example is the encryption key shared between the RADIUS server and the access server.

You can use any of the following optional commands to interact with the RADIUS server host:

- **radius-server retransmit** *number*

  This command specifies the number of times that the router transmits each RADIUS request to the server before the router gives up.

- **radius-server timeout** *seconds*

  This command specifies the number of seconds that an access server waits for a reply to a RADIUS request before the access server retransmits the request. The default is five seconds. If the RADIUS server's response is slow (because of support for a large number of users or large network latency), increase the timeout value.

For more information about these commands, refer to the *Security Command Reference*, which is part of the Cisco IOS configuration guides and command references documentation.

Configuring Authentication on a TACACS+ Server

On most TACACS+ security servers, there are three ways to authenticate a user for login:

- Include a cleartext (DES) password for a user or for a group the user is a member of (each user can belong to only one group). Note that ARAP, CHAP, and global user authentication must be specified in cleartext.

  The following is the configuration for global authentication:

  ```
  user = mswartz {
                 global = cleartext "mswartz global password"
  }
  ```

  To assign different passwords for ARAP, CHAP, and a normal login, you must enter a string for each user that specifies the security protocols, whether the password is cleartext, and if it authentication is performed via a DES card. The following example shows a user carol, who has authentication configured for ARAP, CHAP, and login. Her ARAP and CHAP passwords, "arap password" and "chap password", are shown in cleartext. Her login password has been encrypted.

  ```
  user = carol {
         arap  = cleartext "arap password"
         chap  = cleartext "chap password"
         login = des XQj4892fjk
  }
  ```

- Use password (5) files instead of entering the password into the configuration file directly.

  The default authentication is to deny authentication. You can change this at the top level of the configuration file to have the default use passwd(5) file, by issuing the following command:

  ```
  default authentication = /etc/passwd
  ```

- Authenticate using an s/key. If you have built and linked in an s/key library and compiled TACACS+ to use the s/key, you can specify that a user be authenticated via the s/key, as shown in the following example:

  ```
  user= fred {
  login = skey
  }
  ```

On the access server, you configure authentication on all lines including the VTY and Console lines by entering the following commands, beginning in privileged EXEC mode:

```
2511# configure terminal
2511(config)# aaa new-model
2511(config)# aaa authentication login default tacacs+ enable
```

Caution When you issue the **aaa authentication login default tacacs+ enable** command, you are specifying that if your TACACS+ server fails to respond (because it is set up incorrectly), you can log in to the access server by using your enable password. If you do not have an enable password set on the router, you will not be able to log in to it until you have a functioning TACACS+ daemon configured with usernames and passwords. The enable password in this case is a last-resort authentication method. You also can specify **none** as the last-resort method, which means that no authentication is required if all other methods failed.

Enabling AAA Globally on the Access Server

To use the AAA security facility in the Cisco IOS software, you must issue the **aaa new-model** command from global configuration mode.

When you issue the **aaa new-model** command, all lines on the access server receive the implicit **login authentication default** method list, and all interfaces with PPP enabled have an implicit **ppp authentication pap default** method list applied.

Caution If you intend to authenticate users via a security server, make sure you do not inadvertently lock yourself out of the access server ports after you issue the **aaa new-model** command. Enter line configuration mode and issue the **aaa authentication login default tacacs+ enable** global configuration command. This command specifies that if your TACACS+ (or RADIUS) server is not functioning properly, you can enter your enable password to log in to the access server. In general, make sure you have a last-resort access method before you are certain that your security server is set up and functioning properly. For more information about the **aaa authentication** command, refer to the "Defining Authentication Method Lists" section.

Note Cisco recommends that you use CHAP authentication with PPP, rather than PAP. CHAP passwords are encrypted when they cross the network, whereas PAP passwords are cleartext when they cross the network. The Cisco IOS software selects PAP as the default, so you must manually select CHAP. The process for specifying CHAP is described in the "Applying Authentication Method Lists" section.

For example, enter the following commands to enable AAA in the Cisco IOS software:

```
2511# configure terminal
2511(config)# aaa new-model
```

Defining Authentication Method Lists

After you enable AAA globally on the access server, you need to define authentication method lists, which you then apply to lines and interfaces. These authentication method lists are security profiles that indicate the protocol (ARAP or PPP) or login and authentication method (TACACS+, RADIUS, or local authentication).

To define an authentication method list, perform the following steps, which are described in this section:

1. Issue the **aaa authentication** command.
2. Specify protocol (ARAP or PPP) or login authentication.
3. Identify a list name or **default**. A list name is any alphanumeric string you choose. You assign different authentication methods to different named lists.
4. Specify the authentication method. You can specify multiple methods, such as **tacacs+**, followed by **local** in case a TACACS+ server is not available on the network.
5. Populate the local username database if you specified **local** as the authentication method (or one of the authentication methods). To use a local username database, you must issue the **username** global configuration command. Refer to task 5.

After you define these authentication method lists, you apply them to one of the following:

- Lines—VTY lines or the console port for login and asynchronous lines (in most cases) for ARA
- Interfaces—Asynchronous or ISDN interfaces configured for PPP

The section “Applying Authentication Method Lists” describes how to apply these lists.

1. Issue the aaa authentication Command

To define an authentication method list, start by issuing the **aaa authentication** global configuration command, as shown in the following example:

```
2511# configure terminal
2511(config)# aaa authentication
```

2. Specify Protocol or Login Authentication

After you issue **aaa authentication**, you must specify one of the following dial-in protocols as applicable for your network:

- If you are enabling dial-in PPP access, specify **ppp**
- If you are enabling dial-in ARA access, specify **arap**
- If you are enabling users to connect to the EXEC facility, specify **login**

You can specify only one dial-in protocol per authentication method list. However, you can create multiple authentication method lists with each of these options. You must give each list a different name, as described in the next section “Identify a List Name.”

If you specify the **ppp** option, the default authentication method for PPP is PAP. For greater security, specify CHAP. The full command is **aaa authentication ppp chap**. If you specify the **arap** option, the authentication method built into ARA is used. The full command is **aaa authentication arap**.

For example, if you specify PPP authentication, the configuration thus far looks like this:

```
2511# configure terminal
2511(config)# aaa authentication ppp
```

3. Identify a List Name

A list name identifies each authentication list. You can choose either to use the keyword **default**, or choose any other name that describes the authentication list. For example, you might give it the name isdn-radius if you intend to apply it to interfaces configured for ISDN and RADIUS authentication. The list name can be any alphanumeric string. Use **default** as the list name for most lines and interfaces, and use different names on an exception basis.

You can create different authentication method lists and apply them to lines and interfaces selectively. You can even create a named authentication method list that you do not apply to a line or interface, but which you intend to apply at some later point, such as when you deploy a new login method for users.

After you define a list name, you must identify additional security attributes (such as local authentication versus TACACS+ or RADIUS).

In the following example, the default authentication method list for PPP dial-in clients uses the local security database.

```
2511# configure terminal
2511(config)# aaa authentication ppp default
```

In the following example, the PPP authentication method list name is insecure.

```
2511# configure terminal
2511(config)# aaa authentication ppp insecure
```

In the following example, the ARA authentication method list name is callback (because asynchronous callback is used on the access server).

```
2511# configure terminal
2511(config)# aaa authentication arap callback
```

In the following example, the login authentication method list name is deveng.

```
2511# configure terminal
2511(config)# aaa authentication login deveng
```

4. Specify the Authentication Method

After you identify a list name, you must specify an authentication method. An authentication method identifies how users are authenticated. For example, will users be authenticated by a local security database resident on the access server (local method)? Will they be authenticated by a remote security database, such as by a TACACS+ or RADIUS daemon? Will guest access to an AppleTalk network be permitted?

Authentication methods are defined with optional keywords in the **aaa authentication** command. The available authentication methods for PPP are described in Table 7-4. The available authentication methods for ARA are described in Table 7-5.

Table 7-4 PPP Authentication Methods

Authentication Methods for PPP	Purpose
if-needed	Authenticates only if not already authenticated. No duplicate authentication.
krb5	Specifies Kerberos 5 authentication.
local	Uses the local username database in the access server. This is defined with the **username** global configuration command.

Table 7-4 PPP Authentication Methods (Continued)

Authentication Methods for PPP	Purpose
none	No authentication is required. Do not prompt for a username or password.
radius	Use RADIUS authentication as defined on a RADIUS security server.
tacacs+	Use TACACS+ authentication as defined on a TACACS+ security server.

Timesaver If you are not sure whether you should use TACACS+ or RADIUS, here are some comparisons: TACACS+ encrypts the entire payload of packets passed across the network, whereas RADIUS only encrypts the password when it crosses the network. TACACS+ can query the security server multiple times, whereas a RADIUS server gives one response only and is therefore not as flexible regarding per-user authentication and authorization attempts. Moreover, RADIUS does not support authentication of ARA.

Table 7-5 ARA Authentication Methods

Authentication Methods for ARA	Purpose
auth-guest	Allows guests to log in only if they have already been authenticated at the EXEC.
guest	Allows guests to log in.
line	Uses the line (login) password for authentication.
local	Uses the local username database in the access server for authentication. This database is defined with the **username** global configuration command.
tacacs+	Use TACACS+ authentication as defined on a TACACS+ security server.

Note RADIUS does not support ARA. If you want to authenticate Macintosh users with RADIUS, you must configure AppleTalk to run over PPP, which is referred to as ATCP. For more information about configuring AppleTalk–PPP, refer to the "IP, IPX, and AppleTalk Dial-Up Environments" chapter.

You can specify multiple authentication methods for each authentication list. The following example authentication method list for PPP first queries a TACACS+ server, then a RADIUS server, then the local security database. Multiple authentication methods can be useful if you have multiple types of security servers on the network and one or more types of security server do not respond:

```
2511(config)# aaa authentication ppp testbed tacacs+ radius local
```

If you specify more than one authentication method and the first method (TACACS+ in the previous example) is not available, the Cisco IOS software attempts to authenticate using the next method (such as RADIUS). If in the previous example the RADIUS server has no information about the user, or if no RADIUS server can be found, the user is authenticated using the local username database that was populated with the **username** command.

However, if authentication *fails* using the first method listed, the Cisco IOS software does *not* permit access. It does not attempt to authenticate using the subsequent security methods if the user entered the incorrect password.

5. Populate the Local Username Database if Necessary

If you specify **local** as the security method, you must specify username profiles for each user who might log in. An example of specifying local authentication is as follows:

```
2511(config)# aaa authentication login deveng local
```

This command specifies that any time a user attempts to log in to a line on an access server, the Cisco IOS software checks the username database. To create a local username database, define username profiles using the **username** global configuration command.

The following example shows how to use the **username** command for a user jnieters with password n1vriti:

```
2511(config)# username jnieters password n1vriti
```

The **show running-config** command shows the encrypted version of the password, as follows:

```
2511# show running-config
Building configuration...

Current configuration:
!
version 12.0
! most of config omitted
username jnieters password 7 0215055500070C294D
```

Note The Cisco IOS software adds the encryption type of 7 automatically for passwords. If you were to manually enter the number 7 to represent an encryption type, you must follow the 7 with the *encrypted* version of the password. If you specify the number 7, then enter a cleartext password, the user will not have access to the line, interface, or the network they are trying to access, and you must reconfigure the user's authentication profile.

Authentication Method List Examples

This section shows some examples of authentication lists.

Authentication Method List Examples for Users Logging in to the Access Server

The following example creates a local authentication list for users logging in to any line on the access server.

```
2511(config)# aaa authentication login default local
```

The following example specifies login authentication using RADIUS (the RADIUS daemon is polled for authentication profiles):

```
2511(config)# aaa authentication login default radius
```

The following example specifies login authentication using TACACS+ (the TACACS+ daemon is polled for authentication profiles):

```
2511(config)# aaa authentication login default tacacs+
```

Authentication List Examples for Dial-In Users Using ARA to Access Network Resources

The following example creates a local authentication list for Macintosh users dialing in to an AppleTalk network through the access server.

```
2511(config)# aaa authentication arap default local
```

The following example specifies that Macintosh users dialing into an AppleTalk network through the access server be authenticated by a TACACS+ daemon:

```
2511(config)# aaa authentication arap default tacacs+
```

The following example creates an authentication method list that does the following:

- Enables guest access if the guest has been authenticated at the EXEC facility.
- Queries a TACACS+ daemon for authentication.
- Polls the line (login) authentication password if the TACACS+ server has no information about the user or if no TACACS+ server on the network responds.
- Uses the local security database if there is no line password.

```
2511(config)# aaa authentication arap default auth-guest tacacs+ line local
```

Authentication Method List Examples for Users Dialing In Using PPP

The following example creates a TACACS+ authentication list for users connecting to interfaces (such as ISDN BRI or asynchronous interfaces) configured for dial-in using PPP. The name of the list is marketing. This example specifies that a remote TACACS+ daemon be used as the security database. If this security database is not available, the Cisco IOS software then polls the RADIUS daemon. Users are not authenticated if they are already authenticated on a TTY line.

```
2511(config)# aaa authentication ppp marketing if-needed tacacs+ radius
```

In this example, **default** can be substituted for **marketing** if the administrator wants this list to be the default list.

Applying Authentication Method Lists

As described in the "Defining Authentication Method Lists" section, the **aaa authentication** global configuration command creates authentication method lists or profiles. You apply these authentication method lists to lines or interfaces by issuing the **login authentication**, **arap authentication**, or **ppp authentication** command, as described in Table 7-6.

Table 7-6 Line and Interface Authentication Method Lists

Interface and Line Command	Action	Port to which List is Applied	Corresponding Global Configuration Command
login authentication	Logs directly in to the access server.	Console Port or VTY lines.	**aaa authentication login**
arap authentication	Uses ARA to access AppleTalk network resources	TTY line	**aaa authentication arap**
ppp authentication [1]	Uses PPP to access IP or IPX network resources	Interface (asynchronous, ISDN, or other WAN)	**aaa authentication ppp**

1. If you issued the **ppp authentication** command, you must specify either CHAP or PAP authentication. PAP is enabled by default, but Cisco recommends that you use CHAP because CHAP is more secure. For more information, refer to the *Security Configuration Guide*.

You can create more than one authentication list or profile for login and protocol authentication and apply them to different lines or interfaces. The following examples show the line or interface authentication commands that correspond to the **aaa authentication** global configuration command.

Login Authentication Examples

The following example shows the default login authentication list applied to the console port and the default virtual terminal (VTY) lines on the access server:

```
2511(config)# aaa authentication login default local
2511(config)# line console 0
2511(config-line)# login authentication default
2511(config-line)# line vty 0 4
2511(config-line)# login authentication default
```

In the following example, the login authentication list named rtp2-office, which uses RADIUS authentication, is created. It is applied to all 40 lines on a Cisco 2509 access server, including the console (CTY) port, the 8 physical asynchronous (TTY) lines, the auxiliary (AUX) port, and 30 virtual terminal (VTY) lines:

```
2509(config)# aaa authentication login rtp2-office radius
2509(config)# line 0 39
2509(config-line)# login authentication rtp2-office
```

The following sample output shows lines and their status on the access server:

```
2509#show line
 Tty Typ     Tx/Rx     A Modem  Roty AccO AccI  Uses    Noise   Overruns
*  0 CTY               -    -      -    -    -     0        0        0/0
*  1 TTY  57600/57600  - inout     -    -    -     0        0        0/0
...
I  8 TTY 115200/115200 - inout     -    -    -     0        0        0/0
   9 AUX  38400/38400  -    -      -    -    -     0        0        0/0
  10 VTY               -    -      -    -    -     0        0        0/0
...
  39 VTY               -    -      -    -    -     0        0        0/0
```

ARA Authentication Examples

In the following example, the ARA authentication list bldg-d-list is created, then applied to lines 1 through 16 (the physical asynchronous lines) on a Cisco 2511 access server:

```
2511(config)# aaa authentication arap bldg-d-list auth-guest tacacs+
2511(config)# line 1 16
2511(config-line)# arap authentication bldg-d-list
```

PPP Authentication Examples

The following example creates the PPP authentication list marketing, which uses TACACS+, then RADIUS authentication. The list marketing requires authentication only if the user has not already been authenticated on another line. It is then applied to asynchronous lines 1 through 48 on a Cisco AS5200 access server and uses CHAP authentication, instead of the default of PAP:

```
AS5200(config)# aaa authentication ppp marketing if-needed tacacs+ radius
AS5200(config)# line 1 48
AS5200(config-line)# ppp authentication chap marketing
```

Configuring Authorization

You can configure the access server to restrict user access to the network so that users can only perform certain functions after successful authentication. As with authentication, authorization can be used with either a local or remote security database. This guide describes only remote security server authorization.

A typical configuration most likely uses the EXEC facility and network authorization. EXEC authorization restricts access to the EXEC, and network authorization restricts access to network services, including PPP and ARA.

Authorization must be configured on both the access server and the security daemon. The default authorization is different on the access server and the security server:

- By default, the access server *permits* access for every user until you configure the access server to make authorization requests to the daemon.
- By default, the daemon *denies* authorization of anything that is not explicitly permitted. Therefore, you have to explicitly allow all per-user attributes on the security server.

Timesaver If authentication has not been set up for a user, per-user authorization attributes are not enabled for that user. That is, if you want a user to authorize himself before he has access to network resources, you must first require that the user authenticate himself. For example, if you want to specify the **aaa authorization network tacacs+** (or **radius**) command, you must first specify the **aaa authentication** {**ppp** | **arap**} **default if-needed tacacs+** (or **radius**) command.

Configuring Authorization on the Security Server

You typically have three methods for configuring default authorization on the security server. The following three sample configurations are entries that could exist in a security server's configuration file:

- To override the default denial or authorization from a non-existent user, specify authorization at the top level of the configuration file:

  ```
  default authorization = permit
  ```

- At the user level, inside the braces of the user declaration, the default for a user who does not have a service or command explicitly authorized is to deny that service or command. To permit it:

  ```
  default service = permit
  ```

- At the service authorization level, arguments are processed according to the following algorithm: For each AV pair sent from the access server, the following process occurs:

  1—If the AV pair from the access server is mandatory, look for an exact match in the daemon's mandatory list. If found, add the AV pair to the output.

  2—If an exact match doesn't exist. look in the daemon's optional list for the first attribute match. If found, add the access server AV pair to the output.

  3—If no attribute match exists, deny the command if the default is to deny, or if the default is permit, add the access server AV pair to the output.

  4—If the AV pair from the access server is optional, look for an exact attribute, value match in the mandatory list. If found, add the daemon's AV pair to output.

  5—If not found, look for the first attribute match in the mandatory list. If found, add daemon's AV pair to output.

6—If no mandatory match exists, look for an exact attribute, value pair match among the daemon's optional AV pairs. If found add the daemon's matching AV pair to the output.

7—If no exact match exists, locate the first attribute match among the daemon's optional AV pairs. If found add the daemon's matching AV pair to the output.

8—If no match is found, delete the AV pair if default is deny, or if the default is permit, add the access server AV pair to the output.

9—If there is no attribute match already in the output list after all AV pairs have been processed for each mandatory daemon AV pair, add the AV pair (add only one AV pair for each mandatory attribute).

Configuring Authorization (Network or EXEC) on the Access Server

To specify network authorization, which means that you are preventing unauthorized users from accessing network resources, issue the **aaa authorization network** command. To restrict users from logging into the EXEC facility, issue the **aaa authorization exec** command. See the following example:

```
2511(config)# aaa authorization network
2511(config)# aaa authorization exec
```

Note You can also require authorization before a user can issue specific commands by using the **aaa authorization** command. For more information, refer to the *Security Configuration Guide*, which is part of the Cisco IOS configuration guides and command references documentation.

Specifying the Authorization Method

Authorization methods are defined as optional keywords in the **aaa authorization** command. You can specify any of the authorization methods listed in Table 7-7 for both network and EXEC authorization.

Table 7-7 Authorization Methods

Authorization Methods	Purpose
if-authenticated	User is authorized if already authenticated.
local	Uses the local database for authorization. The local database is created using the **username privilege** command to assign users to a privilege level from 0 to 15 and the **privilege level** command to assign commands to these different levels.
none	Authorization always succeeds.
radius	Uses RADIUS authorization as defined on a RADIUS server.
tacacs+	Uses TACACS+ authorization as defined on a TACACS+ server.

Specifying Authorization Parameters on a TACACS+ Server

When you configure authorization, you must ensure that the parameters established on the access server correspond with those set on the TACACS+ server.

Authorization Examples

The following example uses a TACACS+ server to authorize the use of network services, including PPP and ARA. If the TACACS+ server is not available or has no information about a user, no authorization is performed, and the user can use all network services:

```
2511(config)# aaa authorization network tacacs+ none
```

The following example permits the user to run the EXEC process if the user is already authenticated. If the user is not already authenticated, the Cisco IOS software defers to a RADIUS server for authorization information.

```
2511(config)# aaa authorization exec if-authenticated radius
```

The following example configures network authorization. If the TACACS+ server does not respond or has no information about the username being authorized, the RADIUS server is polled for authorization information for the user. If the RADIUS server does not respond, the user still can access all network resources without authorization requirements.

```
2511(config)# aaa authorization network tacacs+ radius none
```

Security Configuration Examples

This series of examples shows complete security configuration components of a configuration file on an access server. Each of these examples shows authentication and authorization.

Simple Local Security Example

This sample configuration uses AAA to configure default authentication using a local security database on the access server. All lines and interfaces have the default authentication lists applied. Users judithn, jnieters, and enieters have been assigned privilege level 7, which prevents them from issuing the **ppp arap**, and **slip** commands, because these commands have been assigned to privilege level 8.

```
aaa new-model
aaa authentication login default local
aaa authentication arap default local
aaa authentication ppp default local
aaa authorization exec local
aaa authorization network local
aaa authorization
!
username judithn privilege exec level 7 privilege network level 8 password 7 095E470B1110
username jnieters privilege network level 7 password 7 0215055500070C294D
username enieters privilege network level 7 password 7 095E4F10140A1916
!
privilege exec level 8 ppp
privilege exec level 8 arap
privilege exec level 8 slip
!
interface Group-Async1
 ppp authentication chap default
 group-range 1 16
!
line console 0
 login authentication default
!
line 1 16
 arap authentication default
!
```

With this configuration, the sign-on dialog from a remote PC appears as follows:

```
atdt5551234
CONNECT 14400/ARQ/V32/LAPM/V42BIS
User Access Verification
Username: judithn
Password:
Router> enable
Password:
Router#
```

TACACS+ Security Example for Login, PPP, and ARA

The following example shows how to create and apply the following authentication lists:

- A TACACS+ server named dog-house is polled for authentication information (so you do not need to define a local username database). The shared key between the access server and the TACACS+ security server is shepard4:
- A login authentication list named rtp2-office is created, then applied to the console port.
- A PPP authentication list named marketing is created, then applied to group async interface 0, which includes asynchronous interfaces 1 to 16.
- An ARA list named los-banos-office is created and applied to lines 1 to 16.

Note The authentication method lists used in this example use names other than default. However, you generally specify **default** as the list name for most lines and interfaces, and apply different named lists on an exception basis. These names are used only for illustrative purposes.

```
hostname 2511
!
tacacs-server host dog-house
tacacs-server key shepard4
!
aaa authentication login rtp2-office tacacs+
aaa authentication ppp marketing if-needed tacacs+
aaa authentication arap los-banos-office tacacs+
!
line console0
 login authentication rtp2-office
!
interface group-async0
 ppp authentication chap marketing
 group-range 1 16
!
line 1 16
 arap authentication los-banos-office
!
```

RADIUS Example for Login and PPP

The following example shows how to create the following authentication lists:

- A RADIUS server named pig-pen is polled for authentication information (so you do not need to define a local username database). The shared key between the access server and the RADIUS security server is BaBe218.
- A login authentication list named fly is created, then applied to all lines that users can log in to, except the console port. In this example, the console port is physically secure and does not need password protection. The access server is locked in a closet and secured behind a deadbolt lock.
- A PPP authentication list maaaa is created, then applied to group async interface 658, which includes asynchronous interfaces 1 to 16. CHAP authentication is used, because it is more secure than PAP.

```
radius-server host pig-pen
radius-server key BaBe218
!
privilege exec level 14 configure
```

```
privilege exec level 14 reload
privilege exec level 8 arap
privilege exec level 8 ppp
!
aaa authentication login fly radius
aaa authentication ppp maaaa if-needed radius
aaa authorization network radius
aaa authorization exec radius
!
line 1 39
 login authentication fly
!
interface group-async658
 ppp authentication chap maaaa
 group-range 1 16
!
```